DISCOVERY

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Edited by JOHN A. BENN

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Editorial Notes.

At the moment when the report of the international committee of inquiry into the Glozel discoveries is eagerly awaited, by specialists and the public alike, we feel it a matter for congratulation that *Discovery* is able to publish the views of M. Reinach. Except for a few articles that have treated the problem in a general way, there has not hitherto appeared in England an authoritative statement giving the case of those who regard the discoveries as genuine. One of those competent to speak, Mr. O. G. S. Crawford, has in no unqualified terms given the views of a sceptic, in a recent article in the press, and we believe it desirable that those of the opposite opinion should have an equal opportunity for expression. As director of the museum at St. Germain-en-Laye, M. Reinach has been keenly interested since the Glozel finds first came to light, in 1924, and he has personally made enquiries on the site of the excavations. Up to the present time, no less than three thousand objects have been unearthed, and M. Reinach questions whether such quantities of material could possibly have been faked. The most interesting feature of the problem is the hieroglyphics with which many of the objects are marked, these showing a mixture of various ancient scripts that the experts recognize and a number of unknown characters. We do not at present propose to offer any opinions on the Glozel discoveries, except to suggest that, however convinced the one side may be that the other is mistaken, it would be well to keep an open mind until the full results of the inquiry are available. It is not improbable that the committee's report will come as a surprise to many of those who have followed the controversy in all its stages.

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We have received the suggestion that a party might be organized to visit Glozel early in the spring. It is pointed out that, although this hamlet is not far from Vichy, the reports indicate that there are difficulties in reaching the site cross-country, apart from the uncertainty of individual travel arrangements. From inquiries we have made, it appears that not less than twenty-five persons can secure special railway facilities and while we could not ourselves undertake the organization, we should be pleased to hear from any readers interested in the scheme. Travelling towards the end of February, such a party might be accommodated for a week's tour at an inclusive cost of about eleven guineas a head.

*   *   *   *   *

It is always to be regretted when scientific controversy descends to personal aspersions, and the case is the more unfortunate when international considerations are involved. From the correspondence published in its journal, it is clear that the Royal Geographical Society had no alternative than to accept the resignation of Captain Amundsen, who declines to withdraw his imputations of discourtesy on the part of the late Marquess Curzon, then president of the Society. While there is no excuse for a charge based on an inference that Amundsen alone imagines to have been contained in a speech, at a dinner given in his honour, the case is different when he also casts aspersions on a brother explorer. We publish on another page a statement by Captain Wilkins, the leader of the American Airplane Expedition to the Arctic, in which he defends some discoveries of Stefansson that have been disputed by Amundsen. In the autobiography that contains the offending

passage about Lord Curzon, there also appears a charge of dishonesty against Stefansson which, however, has a significance of quite another kind. In suggesting that certain "discoveries" were never made, Amundsen unfortunately again introduces personalities, but he also questions a matter of importance to explorers—whether it is in fact possible to live by hunting on the Arctic sea-ice. We therefore gladly print Captain Wilkins' rejoinder, as he accompanied Stefansson on the disputed journey.

* * * * *

It has become so very usual to regard the condition of the iron and steel trades as scarcely better than that of the coal industry, that special attention may be drawn to a progressive development in Sheffield. On another page, our representative describes the inauguration there last month of a new type of electric furnace, which in order to demonstrate its heat efficiency was enclosed for the occasion in a wooden box. By contrast with the old crucible process, the heat is induced by a high-frequency current passing through the metal itself, so that the contents of the furnace do not come into contact with the fuel. One of the obvious disadvantages of the processes at present employed is that the crucible becomes porous under the heat to which it is itself subjected, and various contaminating materials penetrate into the molten metal. In addition to this improvement, the new apparatus does not appear to cost more in current consumption that the ordinary electric arc furnace. By an interesting connexion, it has been installed at the works where, in 1909, the first electric steel furnace was introduced into England.

* * * * *

We have just received the 1928 prospectus of the Imperial College of Tropical Agriculture, with the principal's report for the past year. Since the arrival of additional staff in Trinidad it has been found possible to extend somewhat the research programme, and good progress has been made. The main crops on which investigation has commenced include the banana. Acting on the recommendations of Dr. A. W. Hill, the Empire Marketing Board agreed to give a recurring grant of £2,000 for five years and a capital sum of £2,350, to provide the necessary buildings and equipment for research on this fruit, and plans for carrying out detailed cold storage experiments are now being considered. Trials with immune varieties have been continued on a field scale, and in addition to the Governor and the Giant Fig, which have continued to yield heavily and exhibit immunity to the Panama disease, two other varieties, Lacatan and Bumelian, have come into prominence, and their cultivation will be extended. Unfortunately these varieties are not entirely suitable for the present methods of transport on a commercial scale, but cold storage and packing experiments may overcome this disadvantage.

* * * * *

Further important objects have been unearthed at Beisan by Mr. Alan Rowe, who is working on behalf of the Museum of Pennsylvania University, and he will shortly contribute to *Discovery* an account of the expedition. Meanwhile, it is reported in *The Times* that he hopes to continue the clearance of the two Canaanite temples of Pharaoh Thothmes III, the middle portions of which only have so far been excavated. From the evidence of the brick pedestals on most of the very low walls of the temples, it would appear that the buildings themselves were screened in with wood; the roofs also were of wood. This screening with wood is very interesting, and is said to be entirely unknown elsewhere in Palestine.

* * * * *

In his Royal Institution lectures on the application of X-rays to the study of crystal structure, Sir William Bragg dealt with a new principle lately evolved, which is of special interest in its application to the study of the silicates. These compounds consist of elements that compose more than nine-tenths of the earth's crust, and the new method of analysis shows that oxygen makes the framework of all these substances. Just as a tapestry consists of woven threads, on which intricate patterns may be placed, so the oxygen atoms are piled tightly together like spheres of uniform size. The other atoms are placed in the interstices, according to a regular design which varies from substance to substance. Sir William proceeded to develop this ingenious analogy, describing how it sometimes happens that the stronger atoms are a little too big for the holes between the oxygen atoms. In this case the regularity is impaired, just as a material "pulls" if that which is embroidered on it is too hard, and takes charge of the pattern.

* * * * *

The Royal Commission on Ancient and Historical Monuments and Constructions of Scotland has recently completed its survey of the romantic Outer Hebrides, Skye and the Small Isles. The country surveyed is remote and difficult to traverse, but at the same time of great archaeological interest. The commission's inventory will be copiously illustrated with plans and photographs, and a special feature is its record of the numerous cairns, stone circles, fortified sites, and earth-houses. Much of the material is recorded here for the first time, and H.M. Stationery Office hope to issue the volume very shortly.

Why I Believe in the Glozel Discoveries.

By Salomon Reinach.

Director of the Museum of Saint Germain-en-Laye.

While it would be premature for DISCOVERY *to express opinions on Glozel pending the report of the committee of inquiry, we believe it desirable that both sides of the question should be presented. We therefore offered space to one of the leading French archaeologists who regard the discoveries as genuine. "If I am not mistaken or deluded," M. Reinach concludes, "a new phase has begun in the study of early civilization."*

Two causes have brought to the fore the hitherto very obscure name of Glozel, a small hamlet about eighteen miles from Vichy, near the rivulet Vareille, which flows into the Sichon: a big discovery and a big quarrel. The discoveries began in 1924; the quarrel has been particularly intense in 1927, and has not yet been settled as I write. It is almost a rule, in the history of science, that every new departure involves some sort of a fight. Science, as condensed in handbooks, resembles a human organism which revolts against the intrusion of foreign elements and strives to reject them. People either say "that is nothing new," or "it is all a hoax." In the case of Glozel, the former opinion is that of M. Camille Jullian; all the polished stones, the vases, the inscriptions, the trinkets, he considers as the paraphernalia or *bric-a-brac* of a Gallic witch, about A.D. 400, and he tries to force a late-Latin key into texts, three thousand years older at least, which can neither be deciphered nor translated.* The latter opinion is that of S. de Ricci, Crawford, Vayson, Dussaud, Bégouen, and perhaps (because he has contradicted himself), the Abbé Breuil: *it is all a hoax.*

Three Thousand "Fakes"?

When asked who was responsible for the faking of 3,000 objects, not one of which reproduces a known type, the answer is: "The Spirit of Glozel," or "That is not our concern, call for the police!" Of course, this all means that the faker is the finder, Dr. Morlet, a most honourable physician at Vichy, or his young help, the peasant Emile Fradin (born 1906), grandson of the farmer who is in possession of Glozel; but fearing to be prosecuted by the French courts, people talk of the "Spirit of Glozel," who, being non-existent, cannot lodge a complaint for libel!

After much dispute, the international Congress of prehistory, meeting at Amsterdam, authorized its *bureau* — president, vice-president, and secretary — to nominate an international committee for investigating the matter. The inquiry was held at Glozel last November and the six delegates, one of whom was Miss Garrod, were left free to excavate as they pleased. Types of almost every object were discovered; but the report of the committee has not yet come out (12th December).

The Site of the Finds.

The site in which the discoveries have been made—first by chance, March, 1924, later on by very careful and slow digging—is a small plateau, dominating the Vareille rivulet, called *Les Durantons.* Not a third of the whole has as yet been explored, and the nature of the early establishment remains doubtful: necropolis or sacred ground, full of votive offerings? Though two and perhaps three tombs have come to light, human remains are rare; the latest opinion is that we are in presence of a cemetery in which partial cremation was practiced. Till the whole *plateau* has been cleared, it seems wiser to state no definite opinion.

The offerings, very few of which may have been of any practical use, are in great numbers; as not the tiniest fragment of metal, nor of Celtic or Roman pottery, has been discovered, and as the imperfectly polished axes and flat rings in hard stone belong to the very beginnings of Neolithic times, the date must be a very early one (3000-4000 B.C.). Such vases as present some analogy with the so-called *owl-vases* of Troy—eyes, heavy eye-brows, a nose, but no mouth—are very much ruder than the Trojan ones. On the other hand, the engravings of animals on pebbles, flat stones, and rings are, though very degenerate, unmistakably akin to the Magdalenian ones, so that if, as I think is necessary, the date of La Madeleine is somewhat brought down, that of Glozel must be very near the close of the Pleistocene times in that part of France. Another cogent argument to the same effect is the existence of at least two engravings representing reindeers, an animal which was believed to have been extinct before the beginning of the Neolithic, and whose co-existence with primitive

* Stupendous examples of such enforced readings have appeared in the *Revue des Etudes anciennces*, 1927.

pottery has been repeatedly denied. But what of the co-existence of the reindeer with a very developed linear script, with inscriptions on clay, one of which numbers over one hundred signs? That is really the crucial point, the great surprise and the sole excuse for so persistent a scepticism.

Early Excavations.

In truth, that revelation was not wholly unprepared. As early as 1865, Lartet and Christy, digging in the caves of the Dordogne, found bones bearing signs which they considered as at least tentative writing; others, with longer series of signs, have been discovered since, and several of them are like the signs from Glozel. The French archaeologist Piette, digging near the Pyrénées, unearthed painted pebbles bearing unmistakable characters, and that caused him to declare in 1896, with truly prophetic insight, that writing had been first practiced at the end of Pleistocene times and that the Phoenician alphabet, far from being the ancestor of all others, was an extract, cleverly made by acute tradesmen, from very numerous alphabets of *western* origin. As early as 1891, indeed, a Portuguese scholar, Estacio de Veiga, had vindicated the local character of the Iberian script, which most scholars derived from Phoenicia. The discovery, first published in 1903, of inscriptions, rude reliefs, and still ruder sculptures discovered under a dolmen of the most primitive type at Alvão in Portugal, seemed to point in the same direction; but those finds, astonishingly similar to the Glozelian ones, though rather later, were rejected as forgeries. A few German archaeologists, in particular Wilke (1912), believed in them, and maintained that they proved the truth of Piette's theory, adopted in 1903 by R. Severo, the clever and unjustly treated editor of the Alvão inscriptions and carvings.* But, with a few exceptions, Piette, Severo and Wilke were regarded as dreamers, and little attention was paid to their writings even after Sir Flinders Petrie (1912) had accepted the hypothesis of early Mediterranean alphabets. Excepting the Portuguese scholar, Leite de Vasconcellos, who went to Glozel in 1926, and myself, nobody seemed to remember Alvão when I showed to the French Academy engravings of those important finds (10th September, 1926). Severo's paper, lost in an extinct periodical, *Portugalia*, ought to be translated and circulated; it is an admirable piece of research work.

The inscriptions found at Glozel have not all been published; but pictures of a number of them—mostly on clay tablets, some on stone and on vases—may be found in the four pamphlets issued by Dr. Morlet and also in the files of the *Mercure de France,* a well-known Parisian magazine, the directors of which were the first to believe in Glozel and to give large publicity to Dr. Morlet's discoveries and writings. I may add that the best general article on the whole question has recently been published by Professor Audollent, Dean of the University of Clermont, in *Le Correspondant* (10th November). M. Audollent repeatedly visited the excavations and, like MM. Espérandieu, Loth, Depéret, and myself, members of the French Institute, and like many eminent French and foreign scholars, witnessed the prudent extraction of all sorts of objects from the yellow bed of untouched clay, at the depth of two feet or so beneath the surface. With the solitary exception of S. de Ricci, who passed there only one morning, all the *unbelievers* never saw an excavation going on; Abbé Breuil excavated under pouring rain and found almost nothing. M. Jullian did not even pay a visit to the museum in the farmhouse at Glozel!

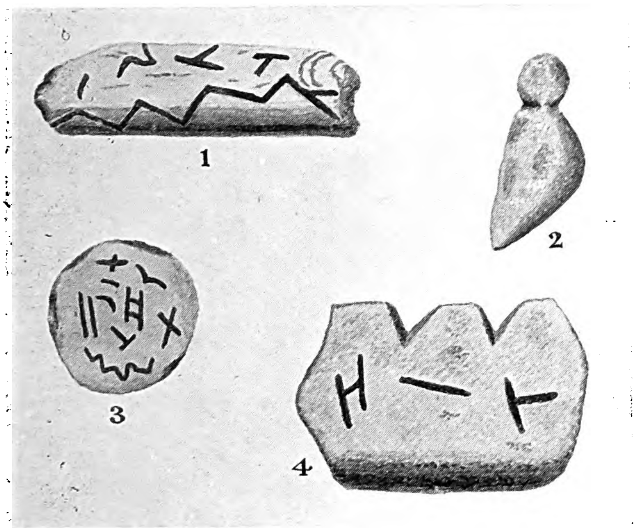
To return to the inscriptions. There are more than a hundred different signs, half of them quite new to us, the remainder offering analogies, which amount often to identity, with the Phoenician, old Greek, Etruscan, Latin, Asiatic, Cretan, Cypriote, Iberian, and Libyan scripts. But, as I first recognized,

CLAY TABLET UNEARTHED AT GLOZEL.
This photograph shows one of the finds made in M. Reinach's presence, while he was inspecting the site. The inscriptions are now under discussion.

* One Englishman, the Rev. Du infield Astley, also believed in Alvão; R. Munro remained in doubt.

the letter B is not to be found, no more than in the Iberian and Etruscan alphabets; moreover, a letter consisting of two opposed triangles, X, which occurs in Iberian and in *one* archaic Greek alphabet, is frequently met with at Glozel. Another familiar letter is T, with two perpendicular bars, only known hitherto in Halicarnassus, where it seems to have sounded *ts*. Imagine a forger—either a medical man or a young peasant—studiously avoiding to write B! As I have often said, that argument, if it were the only one, would suffice to prove that all that epigraphical treasure is genuine.

The engraving on imperfectly burnt clay is sometimes very clear, though irregular, sometimes rather awkward; the inscriptions on stones or vases are always short, but carefully carved, and certainly with the help of a pointed stone, not with any metallic implement.



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OTHER TYPICAL DISCOVERIES.
These pictures, specially painted for *Discovery*, are based on M. Morlet's line drawings. (1) A piece of bone, inscribed with "letters" and a geometrical design. (2) A stone pendant. (3) A pebble disc, showing nine alphabetical signs. (4) A fragment of flaked stone, cut with notches and inscriptions.

Another great surprise was the discovery of more than a dozen clay figures, representing a human face, without a mouth, and the organs of both sexes, one projecting, the other rudely excavated in triangular shape. Nothing like these hideous "idols" has come to light anywhere else. The *unbelievers* are compelled to resort to Freud and to suppose that the youthful forger—a very nice chap—is sex-mad! Such nonsense has even gone into print. Some vases recall the aspect of a dead man's head, with great round eyes, the mouth being always lacking. Dr. Morlet supposed that they were symbols of ever silent death. As the general shape of these vases is that of a head, I prefer to believe that drinking out of skulls may have been one of the origins of pottery. The baking of the clay is, however, so deficient, and the opening so small, that I do not think any of these vases ever served a purpose; like the *impossible* arrow-heads and harpoons—some of them inscribed—and many other things, they were purely votive or funeral, which amounts in so remote times to the same thing.

ANIMALS' HEADS CUT IN STONE.
Two pebbles found at Glozel, one cut with a deer's head, the other depicting an ox. They may have been engraved for hunting purposes.

To sum up. In the obscure period between Palaeolithic and Neolithic, perhaps only in mountainous regions, the reindeer survived and the reindeer hunters also. They had other animals (not yet domestic) and began to cultivate the land; they were inferior artists, but still engraved outlines of animals, for magic or hunting purposes; they used pottery and developed a complicated linear script. Their peculiar civilization was probably common to what we now call France, Spain, and Portugal, but extended to others regions both North and East. Later on, in the Megalithic era, not a trace of that culture remained in France; its bearers must have migrated to the East, following perhaps the Mediterranean shore or the valley of the Danube, under pressure of Northern invaders. How their writing, and also something of their arts and crafts reached the Aegean, we do not know and cannot guess. But the facts are there, and may help in due time to explain some faint traces of scripts in other countries with which the Glozelian culture may have come in touch, rock-carvings in Sweden and in Northern Africa, engraved signs at Tordos in Transylvania, others on Thracian and Trojan pottery, etc. We must look out for such signs with more attention than has been done hitherto, especially in Spain, where we know that the Neolithic culture was very brilliant and spread to Ireland as well as to the North and East of Europe. That means, if I am not mistaken or deluded, that a new phase has begun in the study of early civilization, and that the old saying *Ex Oriente lux* must now—at least before 1500 B.C.—be discarded as prejudice, for the benefit of Western Europe.

New Light on Oceanic Migrations.

By James Hornell, F.L.S., F.R.A.I.

Late Director of Fisheries to the Government of Madras.

Research on the types of canoe found in the widely-scattered islands of the Indo-Pacific region indicates that oceanic migrations took place there centuries before the historic "pioneer" navigations. Magnificent kingdoms undoubtedly existed of which even the names have been forgotten.

It has long been customary to regard the Phoenicians and Carthaginians as the pioneers of oceanic exploration and traffic; they have been credited with voyages to the Pacific and even to the western coast of South America. The merit of their pioneering cannot be gainsaid; they circumnavigated Africa, they trafficked with our British ancestors for tin and may even have worked Cornish mines themselves; they knew the centres where Baltic amber was to be procured, and, a thousand years before our era, at the head of the Red Sea, it was the Phoenicians who built and officered ships of commerce for King Solomon wherewith to open direct trade with emporia on the shores of the Indian Ocean.

Early European Limitations.

They could steer a course by the stars when in well-known waters, but there is no evidence that they did so elsewhere than in the Mediterranean; when voyaging round Africa they tethered their ships to trees at night lest they should drift away in the darkness into the unknown. But that their ships went further afield than the shores of the Arabian Sea—even that only on exceptional occasions when employed by a ruler having an outlet on the Red Sea—is a figment of fancy. One fact alone makes it impossible. The Phoenicians, equally with the Carthaginians, were purely a Mediterranean power when independent, without a maritime base of their own on the shores either of the Red Sea or the Indian Ocean; without one it would have been madness for them to have attempted to carry on commerce under their own flag in foreign waters, where their fleet would be constantly at the mercy and caprice of the ruler of the land through which reinforcements for the ships would have to pass. If it had been otherwise, why did Solomon go to the trouble and immense expense of having ships built at Ezion Geber (the modern Akaba) by the Phoenicians instead of chartering some of their Indian-voyaging merchantmen? The fact that he built instead of chartering seems conclusive evidence that no such Phoenician fleet did exist. On the other hand there is every probability that Phoenician traders voyaged along the coasts of the Indian Ocean in *local* craft, Egyptian, Arabian and Indian, carrying their goods southwards towards the Zambesi, and eastwards to India and the Golden Chersonese, in search of gold and precious stones and pearls.

The first historic record of genuine ocean travel dates to the time when Greeks and Hellenized Egyptians had taken the place of the Phoenicians as sea-traders; the discovery of the value of the monsoon winds of the Indian Ocean for making a direct run to the west coast of India from Africa and Arabia is credited to Hippalos, a Greek sea-captain of the first century A.D.

Excepting the Viking voyages to Greenland and to North America, no further recorded progress in deep-sea travel was made till that far-sighted Portuguese prince, Henry the Navigator—in whose veins it is our pride that English blood mingled with that of his fatherland—founded his famous School of Navigation. Under this impetus, a succession of Portuguese sea-captains mapped the oceanic coasts of Africa and discovered the sea route to India. to the Malay Peninsula, and through Indonesia to China and Japan. It is, however, to Columbus that the outstanding merit belongs of being the first to abandon the slow, coastwise system in favour of deep-sea routes, with implicit trust in compass and the stars as guides.

The final blow to the timid methods of the old sea-school was given by the voyage of Magellan across

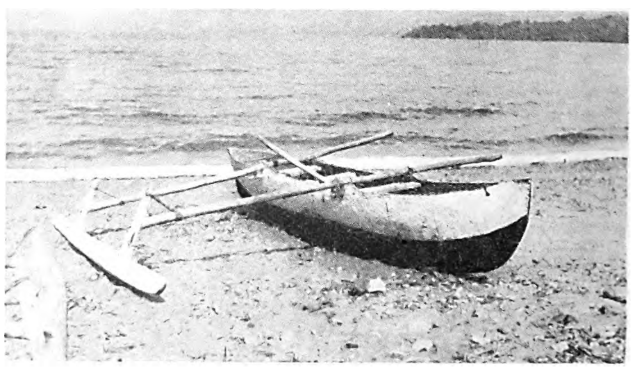


FIG. 1.
SINGLE OUTRIGGER CANOE USED IN MAYOTTE.
Comparison indicates that this form has been derived from the more primitive double outrigger found in Madagascar, to which Mayotte is the nearest island.

the Pacific, an ocean wider and more dangerous to navigation than is the Atlantic; thenceforward mariners of the principal European nations vied with each other in marking out sea-trails over the seven seas, and in locating the myriad islands sprinkled thick as the stars in the sky in the central and western sections of the newly-discovered Pacific Ocean.

But the discovery of the islands was of minor importance in comparison with the fact which became recognized at an early date that a great number of these, irrespective of distance apart, were inhabited by people of one race, of high intelligence, fine physique and speaking dialects of the same tongue. This people, the Polynesians, were linked on in turn to the Mongoloid peoples of the Malay Archipelago, otherwise Indonesia, by fundamental relationship in language and certain features of material culture—

FIG. 2.
DOUBLE OUTRIGGER IN THE COMORO ISLANDS.
A typical survival of the double outrigger, formerly predominant in Madagascar, now ousted almost entirely by the single type

particularly in the common use of canoes fitted with outriggers. Finally, we find a large section of the population of Madagascar to be closely related physically to the people of Indonesia, and the Malagasy language of the entire country to belong to the same linguistic family as those spoken in Indonesia and in Polynesia.

How did these far-flung fragments of the main stocks come to be scattered? By what means did they accomplish such lengthy migrations? Madagascar is separated by an ocean space of some 4,000 miles from Sumatra and Java, the nearest of the Indonesian islands; there have been no stepping stones between, for the people of Ceylon and the Maldives have no near kinship either with Indonesia or Madagascar, whether we look to their racial origin or to their languages; all other islands between, the Seychelles, Mauritius and Rodriguez, were found uninhabited and without trace of former population when discovered by Europeans.

FIG. 3.
A PSEUDO-DOUBLE PASSENGER OUTRIGGER, MADAGASCAR.
With twin masts and a vestigial outrigger on one side, this is a transitional form between the double and the single type. A broken canoe is seen in front.

Similarly in the case of Polynesia, there are inhabited islands and island groups separated by vast sea-spaces from those whence came the original colonists. The Hawaiian Islands lie 2,500 miles north of Tahiti, New Zealand is 1,600 miles from Rarotonga and 2,500 miles from Tahiti, while Easter Island, furthest east of all, is over 2,200 miles from Rapa, the nearer of the two islands whence tradition says it was peopled. The whole assemblage of Polynesian islands covers a vast area, measuring some 4,000 miles by 4,500, all inhabited by one race speaking comparatively unimportant variations of the same language.

A partial solution of the problems involved is to be had by study of the canoe forms now and formerly in use in the various localities; in the case of Polynesia the inquiry is aided most effectively by traditional accounts of several of the more important inter-island migrations.

When Madagascar became known to Europeans early in the sixteenth century, the coastal tribes were wholly without any maritime commerce of their own. Their only vessels were sewn-plank surf boats, akin to the *masula* boat of Madras, and outrigger canoes of small size. Oversea trade did, however, exist, but was in the hands exclusively of Arab and Indian traders and shipowners, the ports on the north and western coasts being frequented by Arab baggalas (the craft usually called "dhow") from Arabia and the Arab settlements on the east coast of Africa, and by Indian kotias from Kutch and Gujarat. Neither of these people has racial kinship with either of the two sections of the population of Madagascar, the Mongoloid one akin to the people of Indonesia, or the Negroid, with its nearest relatives in Melanesia.

Ignoring the latter for the present, by what means did the Mongoloids reach the island from the motherland of Indonesia? It is obvious that they came

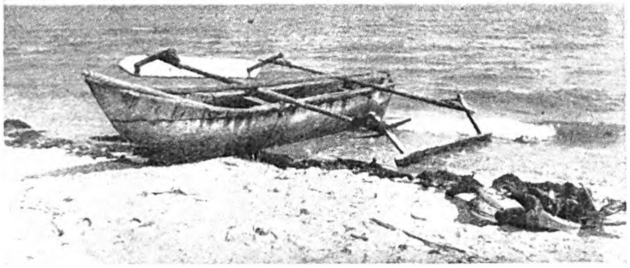


FIG. 4.
ZANZIBAR CANOE, SHOWING OUTRIGGER CONNEXION.
This method (illustrated in detail in Fig. 5) is common to all the native outrigger canoes of Madagascar, the Comoro Islands, and East Africa.

by sea; the land route along the south of Asia is barred, as there is no trace of Indonesian settlement at any intermediate point. Tradition is silent in Malaysia as well as in Madagascar concerning any old-time connexion, and we are driven to the conclusion that the forefathers of the Malagasy were formerly expert sailors, possessed of far larger and better equipped sea-craft than any now existing; that after finding in Madagascar a land big enough and fair enough to meet their requirements, they lacked thenceforward any incentive to continue the hard and dangerous career of sea-wanderers when political conditions caused a cessation in sea traffic with the motherland. Parallel circumstances changed the Polynesians of New Zealand from adventurous vikings to home-staying agriculturists.

Throughout Indonesia the double-outrigger canoe, characterized by a float boomed out on each side, is found common everywhere save in Sumatra, Borneo, and parts of Java, where it has been supplanted within historic times by other types; in Madagascar, the outrigger canoe is equally common along the whole extent of the west coast, the east coast being so surf-beaten and dangerous as to be unattractive to a seafaring population. To-day the Madagascar outrigger vessels are all undecked craft, the hull usually formed of a dugout canoe, with the sides raised by means of a broad plank sewn to the upper edge or bolted to timbers. They are employed entirely within the quiet waters of the great bays and estuaries for fishing and for passenger and light cargo traffic. None is used for voyages outside of the coastal waters of the island.

When the island was first visited, an old record states that double canoes were as common as single ones. To-day the latter have almost entirely ousted the double form, but a majority of the single type exhibit their derivation from the double form by the presence of a thin pole, a vestigial float, attached longitudinally between the projecting ends of the booms on the offside (Fig 3). The conclusion that the Malagasy outrigger boats were originally double outriggers receives definite confirmation when we examine the corresponding craft in the Comoro Islands, a small group lying between Madagascar and Africa. There the single form (Fig. 1) is predominant in Mayotte, the island nearest Madagascar; at Anjuan, further west, the double one is more common than the single, whilst on the African coast, where it has been introduced from the Comoros and Madagascar, all the fishing canoes are furnished with the double outrigger, and are of simpler and more primitive type (Figs. 2 and 4).

That they have all had a common origin is evident when we examine the method of connecting the float or floats with the ends of the booms which project on one or both sides. Amongst the peoples using the outrigger design, this is the point of greatest diversity and importance; better than any other detail, it furnishes evidence of origin and relationships. The canoes of Madagascar, the Comoro Islands, and East Africa (Fig. 4) all agree in possessing a most peculiar and characteristic type of connexion, the essential feature of this being the insertion of the end of each boom *through* a hole in the shaft of a connecting bar, which may be either short and peg-like or elongated into a broad stanchion-like form (Fig. 5).

In Indonesia we find a perplexing variety of methods employed to connect the booms with the floats. One very common type seen commonly in Lombok and Halmaheira is where a recurved rod is employed very like the elongated stanchion type of East Africa, but with the boom lashed to its upper end instead of perforating it. Still more closely related in form is a type seen in certain degenerate fishing canoes on the north coast of middle Java. In these, which are single outriggers, a single boom only is employed,

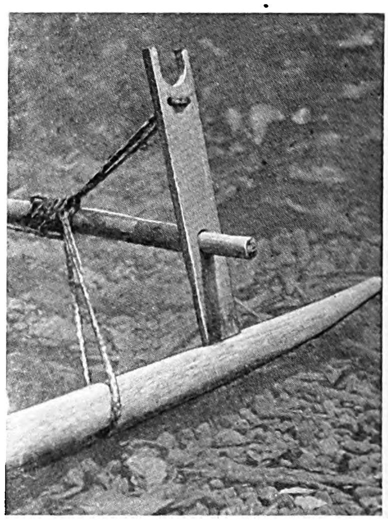


FIG. 5.
BOOM AND FLOAT CONNEXION.
The essential feature of this type of connexion is the insertion of the boom *through* a hole in the bar connecting with the float.

the connexion being by means of a short board, inserted below into the upper surface of the bamboo float, and with the bamboo boom passed through a hole in the upper end. Nowhere else in Indonesia is this form of connexion employed, and there is every reason to consider it as a degenerate survival of the method employed in the outrigger vessels of one of the waves of Indonesian emigration that surged upon the coast of Madagascar many centuries ago.

In general the outrigger craft of Indonesia at the present time are too small and frail for the journey of 4,000 miles from Java to Madagascar, though the large cargo outriggers to be seen any day in the old Javanese seaport of Grisee are conceivably equal to the voyage (Fig. 7). Even these are small in size compared with those the Javanese possessed a thousand years ago. What they were then the sculptured panels of the great Buddhist shrine of Boro Budur mutely testify (Fig. 6). On them are to be seen graven in high relief the representations of several large, two-masted, outrigger ships, probably as large as the ships in which Columbus and the Pinzons crossed the Atlantic. In one panel a vessel is shown with a massive compound float made up of several logs lashed together and attached by curved intermediaries, resembling the Lombok type, to squared booms obviously of exceptional strength. In such a large and strongly built vessel carrying a large sail area a voyage across the Indian Ocean would present no special difficulty, particularly on the southern side of the equator. But, so far as we know, direct communication between the motherland and her African colonies had ceased several centuries before Boro Budur was built (*circa* 8th century); unlike modern Javanese, the Malagasy language contains few, if any, words of Sanscrit origin, excepting those introduced at a comparatively recent date by Hindu traders, a proof that the last wave of colonization reached the island before or concurrent with the conversion of Sumatra and Java to Buddhism and Brahmanism in the early centuries of our era.

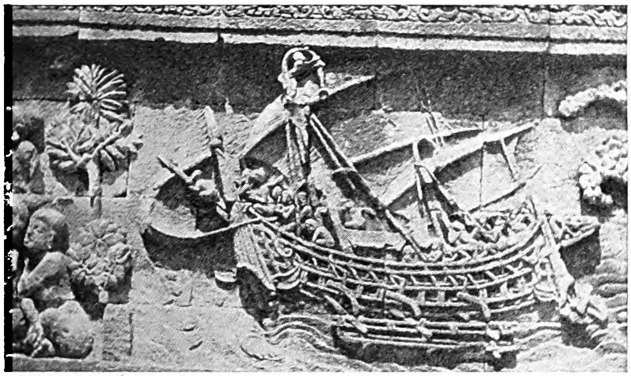


Fig. 6.
AN EIGHTH CENTURY JAVANESE VESSEL.
A large sea-going double outrigger is pictured in this sculpture, which is part of a panel in the great Buddhist shrine at Boro Budur.

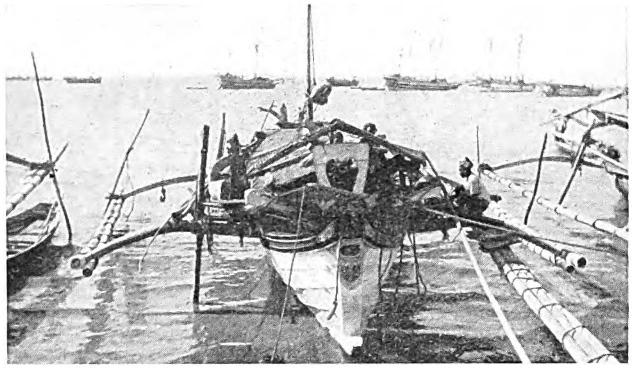


Fig. 7.
LARGE MODERN OUTRIGGER AT GRISEE, JAVA.
While such vessels might conceivably sail 4,000 miles to Madagascar, the voyage from Java was probably undertaken in much larger boats during the ocean migrations of two thousand years ago.

There was far more movement in the Indo-Pacific area, 1,000 to 3,000 years ago, than is generally recognized. Old kingdoms of great magnificence and extent undoubtedly existed whereof the names even have been forgotten, though occasionally a ghostly shadow may be recovered by patient research; an example of this is that notable discovery by Gabriel Ferrand of the existence in Sumatra, at a date somewhat prior to the building of Boro Budur, of a powerful kingdom with its capital at the modern Palembang, which exchanged embassies with China and held power even on the mainland of Asia. In its homeland the name and memory of this kingdom had vanished as though it had never been, and only from the historical records of China has it been possible to reconstruct a slight outline of some incidents in its story.

With the knowledge that the Javanese possessed large sea-going outrigger vessels as late as the eighth century, when Indian influence and religion had been powerful for several centuries in the land, and that the Malagasy language contains few Sanscrit words, these, together with other considerations, justify us in placing the latest migration of Indonesians to Madagascar at a date about the beginning of our era. It is not unlikely that this final movement coincided with the settlement in Java and Sumatra of large numbers of warlike Indians, and with the efforts successfully made by these adventurous bands to acquire ruling power and to impose their religion upon the mass of the inhabitants. If the last wave of immigrants into Madagascar fled there to escape a foreign yoke, we can understand the reason for a

subsequent severance of all ties binding them to the motherland. As a consequence of the loss of free and frequent intercourse with their kinsmen across the sea, and the ease of life in a sparsely inhabited and fertile country, culture would stagnate and the people would quickly lose that spirit of adventure which they must have possessed to induce them to brave the hazards of a voyage across the Indian Ocean.

I have been careful to restrict these references to the last influx of colonists, that which probably brought the ancestors of the Hovas to the island. Authorities agree generally that there must have been several preceding surges of immigration; if so, this indicates a long-standing knowledge of this particular sea route. There are, indeed, several indications; among others, the ancient reference unearthed by Ferrand recording a visit to Aden of trading vessels believed to have come from Madagascar, and the prevalence of an Indonesian type of outrigger over the greater extent of the East African coast—from Port Amelia in Mozambique, continuously northwards to Lamu, near the border ot Italian Somaliland. It is not unlikely that Indonesian trading ships, either from Sumatra or Java, or from their colonies on the coast of Madagascar, had trading posts and even settlements at convenient ports on the African littoral.

Vikings of the Pacific.

The greater problem remains: By what means did the negroid tribes reach the island? There can be no real doubt that they are derived from the Oceanic Negro stock that peopled Indonesia prior to the Mongoloid influx, and which in its undiluted state persists in New Guinea as the Papuans and in a mixed condition throughout Melanesia. Their physical affinities are distinctly Melanesian and their language has scarcely any relationship to any in Africa—what little there is, being due to the influence of slaves imported from the adjacent mainland. The African negro has no sea instinct; he has never built any seagoing craft; in these characteristics he agrees with the Papuan negro of pure stock. It is otherwise with the Melanesian; his negro blood has been vivified by admixture with that of a more adventurous race, and though he has been ranked lower in the latter quality than the Polynesian, he has been a marvellous canoe-builder and was able to give lessons in this even to the latter. No finer pre-European vessel has ever been built in the Pacific than the old-time Fijian double-canoe. The Tongans, vikings of the Pacific, are known to have discarded their own type of double-canoe for that of Fiji. Samoa did the same. Even to-day the Melanese fishermen of the northern coast of Papua build the finest type of single outrigger now existing; on it, in a neat cradle, they carry a dugout canoe as a passenger steamer carries lifeboats. A wide platform, laid upon the booms, gives accommodation for a considerable number of persons, and the outrigger is so stoutly built that it can weather heavy seas with safety.

Early Colonies.

There are indications in many islands of the Pacific, even in distant New Zealand and the Paumotus, of an admixture of Melanesian blood. We know that the Polynesian race has degenerated out of all likeness to its past glory; at one period its energy was enormous —no sooner had it waxed numerous in one island, than exploring expeditions were sent out; following them, swarms of colonists hived off to whatever new lands were discovered. To-day, however, they show no more energy than do the Melanesians, usually even less.

If the one race has passed from a virile manhood to lethargic senility, is it not reasonable to suppose, in face of Melanesian blood in Madagascar and in far-sundered isles in the Pacific, that they too had their noontide of seafaring energy, that in their outrigger vessels they also founded colonies in Madagascar at a period far antedating the migrations thereto of Mongoloid Indonesians? It is probable that it was the pressure of an invading race on the homelands of the Melanesians that caused the latter to seek refuge across the sea. Aided by the trade-winds and the westward-moving equatorial current, a journey from Java to Madagascar in the fine outrigger vessels of the Melanesian fishermen of Wakde in Northern Papua, if properly provisioned, would be a far easier journey than that performed by Bligh from the coast of Tonga to Timor, or that of the *Trevassa's* boats from off Australia to Mauritius and Rodriguez. Whether the first journey was made under the impulse of the adventurous spirit, as were many performed by Polynesians in olden days, or was an unpremeditated drift voyage, it is certain that these people were in fit condition to return and tell the tale, and thereby initiate recurring migration or rather colonization. And the earliest of these movements must have consisted of people of Melanesian race.

The ocean voyages of the Melanesians have unfortunately been given little attention compared with those of the Polynesians owing to their greater remoteness from our own time; did we know as much about them as of the latter, we should probably find them equally wonderful and daring, and possibly as widely spread.

The Cuna Indians of Panama.

By Erland Nordenskiöld.

The Götheborg Museum, Sweden.

In our November issue Professor Nordenskiöld gave an account of the first discoveries of the Swedish expedition which has just returned from Central America. During the concluding travels a visit was paid to the president of a remarkable Indian republic.

In a previous article I have given some account of the Chocó Indians, and here I propose to touch upon the Cuna, or Tule, Indians. This notable tribe, among whom the Scots founded their famous colony in 1699, is to this day to a large extent quite independent. In the old piratical days the Cunas befriended the pirates and assisted them against the Spaniards. Their sympathies have always greatly leaned towards everything British, and an exceedingly valuable account of the Cunas of the seventeenth century has been written by the Englishman, Wafer.

We had anchored our motor-boat "Olga" off Ustupu, or Portogandi, one of the largest villages of Tule, the Cuna republic on the Atlantic side of the Isthmus of Panama. It is a small island lying a mile or so from the mainland, and is built all over with huts, for in these parts the Indians live on small islands off the coast, where they are clear of mosquitoes and, incidentally, of malaria also. All their cultivations, with the exception of their cocoa palms, are situated on the mainland whence fresh water has to be fetched daily, there being none on the small coral islands off the coast. In the mornings the women may be seen crossing over to the mainland in their canoes with a multitude of calabashes for bringing back water and the men also go over to look after their cultivations and to hunt game. This mode of living is of comparatively recent origin, as only a hundred years ago all the Cunas were living on the mainland.

In a very few moments our boat was invaded by swarms of Indians who had come out to us in their canoes, but only men and boys, and no women, had ventured out. Their canoes, made to carry sail, are dug-outs with both ends peaked to a fair elevation, and seem to possess fine sea-going properties. The Cunas are excellent seamen, and many of them have signed on in ships at Colon and sailed far and wide. They have mostly been to England and North America, and there are many who speak English fairly well. We came across two Cunas who had been to Sweden, and were told of one man living in the village of Ailigandi who could speak Swedish. He, like so many other Cunas, had taken an European name and called himself Lyon. Fine-sounding names are popular, one headman even having adopted the name of Napoleon Bonaparte, though otherwise being a person of no particular importance. Other names are Martin Luther and Henry Clay, but generally speaking the Indians have genuine native names.

INDIAN SAILING-CANOES.

The art of sailing is a recent accomplishment learnt from the white man, but the Cunas are nevertheless excellent seamen. They live on islands and use canoes to reach the mainland.

Among our visitors on board were the chief's sons, and we received invitation to call on him ashore. We were somewhat apprehensive as to what our reception there would be like, for since February, 1924, when the Cunas revolted and killed the policemen that the Panama Government had stationed in their villages, no foreign vessel had put in at Ustupu, and we knew that the Cunas were not to be trifled with. A few years ago a party of rubber-seekers on the mainland had entered Cuna territory. They were given notice to clear out within twenty-four hours, but did not take this warning seriously, consequently the chief ordered that they should be killed, and his command was

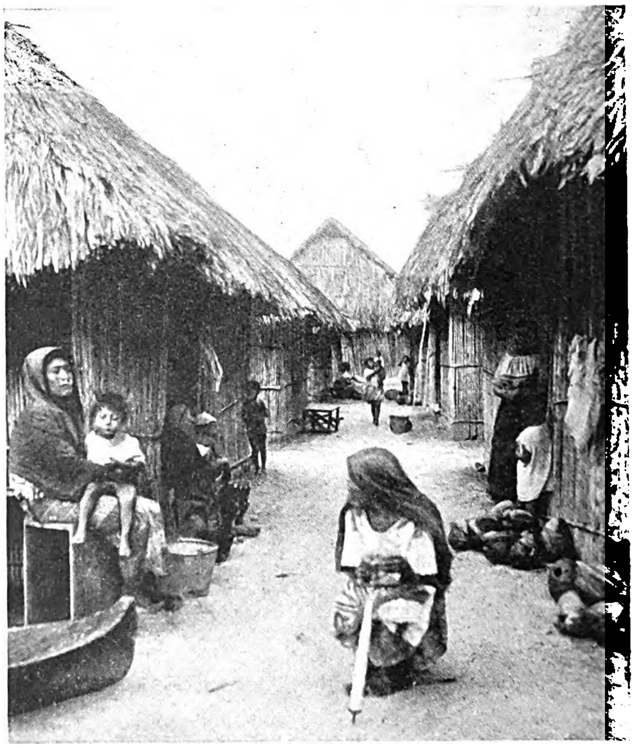
CUNA WOMEN AND CHILDREN.

Not only are elaborately woven dresses and beads worn, but the women and girls wear a nose ring of gold, even before they have learnt to walk.

duly carried out. Thus there is at the present time not a single negro or white man living in the Tule Republic, although this branch of the Cunas are not only formally but also actually under the authority of Panama. By the word "white" in this connexion I am referring to persons of European descent, as there are so-called "white Indians," *i.e.*, albinos. It is gratifying to notice how the Indian stock here is untainted by admixture with negro blood, a point on which the Cunas have always been very strict. At the massacre of the black policemen the Cunas also killed the children the negroes had by Indian women, and such of their own women who were pregnant to negroes were compelled to procure abortion.

A small motor-boat was got ready to take us to the landing-stage. At this spot, as on most of the huts, the flag of the Tule republic is flown, which has an orange-coloured middle portion showing a blue swastika, and blood-red borders. On one solitary house the flag of Panama had been hoisted, this representing a minor section among the Indians who desire reconciliation with the Republic of Panama. The sea teemed with life and movement, canoes approaching from the mainland loaded with water and produce from the cultivations. The country struck us as out-and-out Indian. The harbour was thronged with boats, on many of which the sails were spread to dry. Boat-sailing is a recent accomplishment of the Indians, who learnt it from the whites. As we stepped ashore we were met by a crowd of men, women and children, the latter, however, being somewhat shy. In this crowd they constitute the picturesque element, with their quaint dresses sewn in embroidered pattern and fancifully ornamented, their nose rings of gold, and their enormous golden ear-pendants. We saw about us as much gold as if we had arrived among the Indians at the time of the Conquest. The men, on the other hand, wear shirts, trousers, and a hat, and when ponderous golden ear-drops are worn in conjunction with this European apparel, the effect is somewhat bizarre.

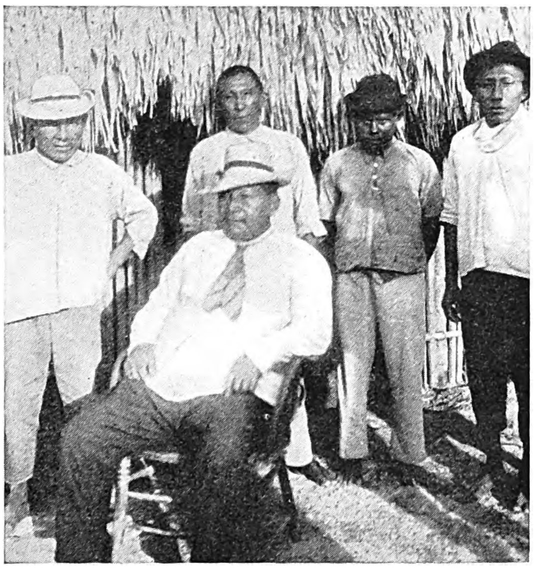
In the village the houses are built very closely together, two houses sometimes having one wall in common. They are of rectangular shape, built of logs and roofed with palm leaves. The floors consist only of earth stamped down, and hammocks are used for sleeping. The streets are narrow and most irregular. Here and there is a small plantation in which flowers are grown; in some of these plots even roses may be seen. The village is clean and well-kept, the satisfactory hygienic conditions being in part due to the presence of water-closets that are built overhanging the water. The Cunas are of great personal cleanliness, as they always bathe in fresh water, while the children habitually play on the sea-shore.



A VILLAGE STREET SCENE.

The houses, built of logs thatched with palms, are placed closely together on narrow irregular streets, but the Cuna villages are clean and well-kept.

The children were keenly interested in us, the more so since I distributed a few trifling presents among them. The small girls looked very comical, wearing golden rings in their noses even before they had learnt to walk, and they were dressed in exactly the same way as the grown-up women. Our objective was the assembly hall, a building of much the same kind as the rest. At one end there were terraced seats surrounding an open space in which were a few hammocks and chairs. At our entry we found the place packed with people, the chiefs and elders occupying the seats in front, behind them being the rest of the men and, farthest back, the women and children. We were asked to sit down, though the chair assigned to the head chief was still empty. Like royalty nearer home he prefers to defer his appearance until the gathering is complete! We were fortunate indeed, for we had happened to arrive while an election for chief was in progress. Napoleon Bonaparte of Isla de Pinos was there, as also the chief of Carti, a village of five thousand Indians, and presently there arrived the head chief of Tulehuala, *i.e.*, of the Cunas of the interior of the mainland, whose district no white man has ever visited.



THE CHIEF OF THE CUNA INDIANS.

The Cuna Republic is governed by election among the Indian chiefs, and the head chief is here seen. The men wear semi-European clothes but go about bare-footed.

After a brief spell of waiting there entered a stout little gentleman dressed like the rest of the men, and, like them, bare-footed. This was El Néle, president of the Republic of Tule, and a great medicine man withal. We saluted him, and he gave us a friendly greeting in return. I offered him some cigars and presented him with an alarm clock with luminous figures. Through the interpreter I explained to the chief why we had come and what we were after. I suspect that he understood my Spanish quite well, but nevertheless everything said had to be translated into Tule or Cuna. Besides, he knew who I was, for that had been read out to him by his secretary, Ruben Perez Kantule, from a Panama newspaper. Ruben subsequently proved of inestimable service to us. He had been to school in Panama, but in the revolution of 1924 he had joined the revolting Indians, and hated the Panameños from the bottom of his heart. Now he was one of El Néle's secretaries, and was of very great use, as he could write Spanish almost perfectly, and was intimately acquainted with conditions in the town of Panama. Ruben told El Néle that we collected things to write books about, and to put in a museum, and he then explained the nature of a museum.

El Néle was a trifle suspicious to begin with, but gradually he thawed. No doubt this was partly accounted for by the fact that, like his good countrymen, he had no objection to doing a little financial exploitation of us, everyone finding he could do with our trading-wares and dollars. I broached the question of obtaining permission to take photographs. Only those Cunas who have been about the world are opposed to photographic operations. "We do not want to see our women on picture cards," they say. El Néle gave us leave to photograph down at the harbour, and not in the village itself, but later on we were free to snapshot anywhere—if we paid in tobacco!

People in high places generally liking to be flattered, and I told him, through the interpreter, that I had heard great reports of his wisdom, and asked him if he would not let me also profit by it. He promised to receive me in a second audience next morning at eight o'clock, with the added injunction that I must be punctual. The alarm clock I had given him had already been hung up on a pole opposite El Néle's seat in the assembly hall.

After that we bid adieu for the time being, and returned aboard the "Olga," which was beleaguered far into the night by Indians eager to carry on a bartering trade with us, or wishing to sell us bows and arrows, women's dresses, and other things. Although my wife was present, the women still kept away. The next morning I presented myself punctually at the appointed time at El Néle's, and then with the greatest willingness he told me many things about the Cuna Indians' beliefs in God, the nether world, and so forth. I also succeeded in collecting a great deal of information about the Cunas' conceptions of illness, much of which the Indians have recorded by means of their exceedingly remarkable picture-writings.

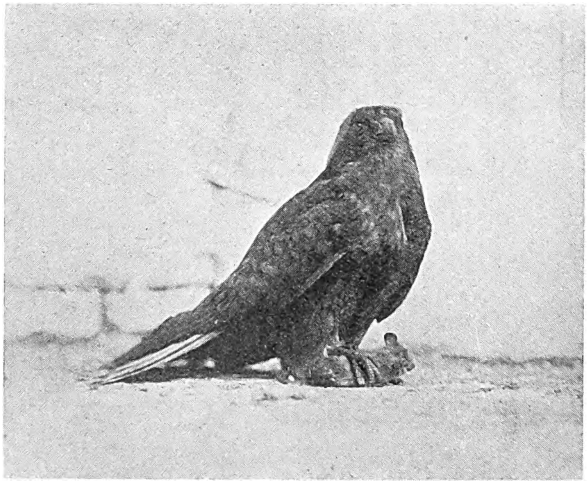
Researches on the Economic Factor in Birds.

By C. J. Patten, M.A., M.D., Sc.D.

Professor of Anatomy in Sheffield University.

While bird protection measures have lately been given considerable public attention, the ruthless destruction of many common species proceeds apace. Yet some of these are most helpful to farmers, fruit growers, and others, who do not always trouble to discover their value.

An old and useful adage warns us not to kill the "goose" which lays the "golden egg." This goose stands sponsor for most species of our wild birds which, in a state of nature and under ordinary well-balanced conditions, lay the golden egg. In other words, in the light of the economic factor, the existence of the bird creation benefits man. Furthermore, not man individually but nations at large reap these benefits.



KESTREL WITH CAPTURED MOUSE.

This charming little falcon deserves our protection, as it keeps the ravages wrought by small rodents and pestilential insects largely in check.*

But at the outset it may be asked—What about feathered vermin? The answer is not far to seek. The term "vermin" as applied to birds has no analogy to vermin in its strict sense. Lice, bugs, fleas, tape-worms, mosquitoes, horse-flies, and many other pests which attack man individually, whenever they can get a foothold, are vermin in the absolute sense. Here it is the duty of the community to aid in checking vigorously the onroads of these pests. It matters not whether sanitary officers, medical inspectors of schools, or any other sect are told off to carry out this task, the principle holds good that all of us are deeply concerned in favour of destroying, nay more, of stamping out these obnoxious pests whenever possible. Hawks, owls, crows, and magpies, are not by any means vermin in the absolute sense. These birds have never deserved such a degraded misnomer. They are only vermin in the eyes of the game-keeper who, in the interests of his master, promptly puts an end to their lives if they dare enter his game-preserves. In many instances these very predacious birds are frequently mere wanderers, which, if unmolested, would pass in at one end of the forbidden ground and out at the other without further ado, especially when affecting a migratory movement. Again, apart from game, other creatures in abundance inhabit many preserves. Such are often the selected quarry of the "vermin." It is obvious then that here the use of the term "vermin" is on the whole misleading. True, all of us may not be equally concerned with the sad destiny which awaits hosts of birds of prey.

There are, however, great numbers of nature-lovers who with deep regret learn of the wholesale diminution in numbers of any kind of bird through its being specially ear-marked for destruction. Apart from the question regarding the decided economic value of birds of prey (a point which I shall deal with presently), it always seems unfair to the zealous ornithologist that on account of game preservation having such an exclusive monopoly in many districts, hawks and owls are almost wiped out; consequently their intensely interesting habits (especially their magnificent wing-movements), cannot possibly be studied. One likes to think of a game-keeper—and we know that nowadays there are many—as a man of discrimination, who, by consulting books, and by taking an intelligent interest in the feathered world, can make up his mind to spare that splendid buzzard, which he has just disturbed in the act of devouring a rabbit, captured from among hundreds of grouse which stock the moorland scene! It is, indeed, painful to think of a game-keeper or anyone else allowing himself, through sheer carelessness and ignorance, to become a wholesale exterminator of birds of prey over a large tract of moorland or covert. What does the farmer say when his corn-stooks are studded with flocks of chaffinches, greenfinches, and sparrows? No doubt he brands the ravagers of his crops as "vermin." But then,

* As in the previous articles in this series, the photographs are taken from life by the author. The illustration on page 17 is of a specimen which he collected and mounted.

BIRDS OF PREY IN THE ORIENT.
It is fascinating to watch the superb aerial movements of birds of prey at ports in the East. Kites predominate, but buzzards and eagles also help to swell the numbers. The birds, in search of offal, hover and glide with buoyant grace alongside the ships, pieces of meat cast overboard being often snatched up before reaching the water. The photograph was taken at Aden from the deck of a steamer.

why are the birds not only so numerous but also so persistent in their destructive work? Because man—and we must include the farmer himself—has ruthlessly destroyed not only the "goose" but also its "golden eggs" whenever possible, here perforce the sparrow-hawk! "A sparrow-hawk left to himself even by scaring the sparrows from ripe grain will save the wages of at least ten boys," says Mr. E. Newman, F.Z.S. Let me give an appropriate example which came under my own personal notice.

A field of ripe wheat, flanked by trees and bushes, afforded a sparrow-hawk a favourable opportunity of stealing on his quarry unawares. A finch from amidst hundreds in the field was easily surprised and snatched away, so that here the hawk found a happy hunting-ground. So persistent were the small birds in their greed to devour the grain that the presence of the hawk three or four times a day did not drive them from the neighbourhood. But after each capture was made the flocks betook themselves to the road-side, gardens, and sea-front, where they remained for some two hours and gathered whatever food-stuffs were obtainable. They had not returned to devastate the wheat e'er long before another of their companions was borne away, and again the grain was deserted for a few hours. The hawk partook of about four meals a day at quite regular intervals. We will say he had his "breakfast, dinner, tea, and supper," and while he only reduced the numbers in the flocks (of several hundreds) by four birds a day, his visits were such a splendid deterrent that he saved the owner of the crops many sacks of wheat in the season. Nor has the story come to an end. In the fading twilight of a beautiful September evening I descried a white or barn-owl quartering the ground of the same field with the regularity of a pointer dog. He also frequently re-visited this hunting-spot, and on more than one occasion I saw him glide down on noiseless wing and pick up his mouse. As Tennant says:

"Now may we follow on his curving flight,
The white owl mousing in the failing light."—

How many mice were secured during the night by him (and there is no reason to suppose that another owl did not participate in the same hunting-grounds, for they often appear in the plural number) after I had retired to rest I cannot say, but there is no doubt that the owner of the crops reaped an inestimable benefit by the presence of these birds of prey.

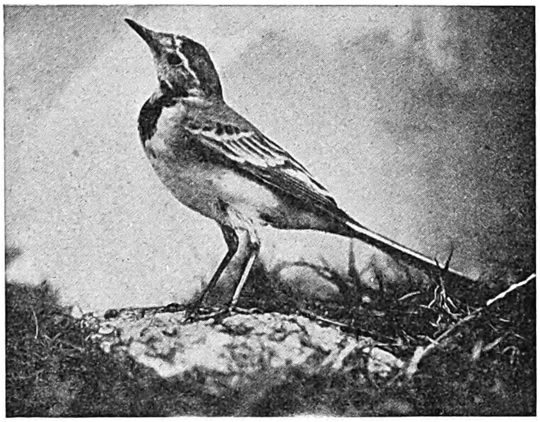
I have still a word or two more to add to my story. Adjacent to the corn-field was rough pasture-land, studded here and there with furze bushes, thistles, and rag-weed. Parties of twittering goldfinches, exquisitely beautiful birds, perched on the thistles, were regailing themselves, the seeds of which we know are their favourite food. They little heeded the kestrel hawk who above them on fluttering pinions appeared motionless as though suspended by an invisible thread. When, however, the charming little falcon dropped like a stone to earth, and picked up his grasshopper or beetle, rose again, poised, and repeated his swoop to earth, the sprightly goldfinches, having by this time had a hearty meal, grew mischievous and

took it into their heads to mob the bird of prey. As Keats says, they

> "Sip and twitter and their feathers sleek;
> Then off at once, as in a wanton freak."

In his endeavours to evade his pursuers the kestrel attracted the attention of some of the other finches, who, relinquishing for the time being their ravages on the corn, joined in the game. He then perched on a telegraph-wire, where all the little birds, numbering about forty, arranged themselves in line on either side of him. Now for a brief space of time we have a pretty view of hawk and finches fraternizing harmoniously. Presently, however, the kestrel took wing, and I finish my story by telling you that his intrepid lesser companions followed him for a short distance in order to see him safely off the premises! The kestrel—probably on the whole the most numerous, and certainly the most widely distributed of our British hawks—cannot be mistaken. His reddish-brown back and wings in the first place distinguish him from the other British hawks, whose upper plumage is dark slaty-blue or brownish-black according to age, sex, and plumage. Secondly, he is the only one of our hawks who suspends himself in the air when searching for his quarry, his wings all the while vibrating so rapidly as to appear motionless. For this reason he has been called the "wind-hover." He should never be shot, because the percentage of small birds which he kills is exceedingly low and as far as game-birds are concerned he can present practically a clean sheet. As far back as 1906, I published a series of articles in the *Irish School Monthly* dealing with "the economic uses of birds," in which I stated: "I have examined the gizzards of over two hundred kestrels, and in only twelve of these have I found the remains of small birds, and in five of the twelve cases the kestrels were shot in the breeding-season when the extra task of catering for their young was thrown upon them. As I write I am watching my pet kestrel in the garden with the sparrows hopping round him."

But it is to the agriculturist that he is the real benefactor. For while he refrains from joining hands with the sparrow-hawk in saving the crops from the ravages of grain-eating birds, he checks the ravages wrought by mice, voles, young rats, beetles, and other deleterious insects. At sundown he retires to rest and his place is taken by the barn-owl, the tawny owl, the long-eared owl, and the short-eared owl, when the raid on mice is renewed, and a heavy toll of larger rats, some quite full-grown, is enacted. Is it any wonder then that Lord Lilford once said that the man who shot an owl is only fit to be in a lunatic asylum!



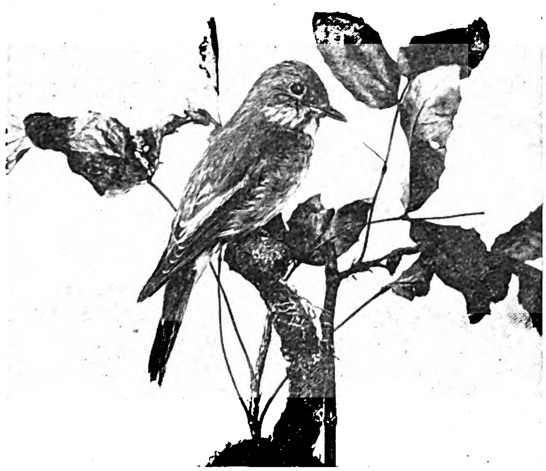
THE PIED WAGTAIL.

Wagtails, as a race, are exceedingly active and evince an insatiable appetite whenever flies buzz around. The insects are snapped up and demolished with amazing rapidity.

The carrion crow (or perhaps his congener the hooded crow) appears on the grouse-moor in the breeding-season. Must this pirate go under the moment he crosses the threshold? Lower your gun, wait a minute! Listen! a far-reaching melodious whistle is being wafted on the breeze and is growing more distinct, and look! the crow has already turned tail, but not before the valiant curlew is abreast, screaming, and mobbing him remorselessly. The guilty and suspicious crow, fearful of being observed, fearful of other and more deadly enemies being attracted to the scene, beats as hasty an escape as he can, and entering cover rejoices that his escapade has not terminated in disaster. Curlews and lapwings breed on the moors. They will fearlessly attack and drive off the raven, crow, or hawk, and in this way fortuitously shield the grouse and their eggs or chicks. Crows as a race are almost omnivorous, and their depredations on game are, on the whole, over-rated. Keep them in check should they get the upper hand which is very unlikely. But for the sake of the student of ornithology pray do not exterminate them from a district. In the East, birds of prey and crows are not interfered with, and rightly so, for they are most useful scavengers. I was, indeed, infatuated with the superb aerial movements of large numbers of vultures, eagles, buzzards, kites, and crows, which I witnessed at Aden, Bombay, Columbo, and other Eastern ports. The crows accept food in many cases from the hand, and the hawks swoop exceedingly close by and seize in the air pieces of meat thrown to them. Many years ago the larger birds of prey were a dominant feature of bird-life in the British Isles. Now most of them are gone. The golden eagle under rigid protection survives in limited numbers in the

remote Scottish Highlands.' South Wales alone offers a retreat for a few surviving kites, a bird which formerly was plentiful about London city and its river estuary. As we watch these splendid birds in all their glory in the East, it grieves us all the more to think that they have now almost vanished from our isles.

Let us for a moment turn our attention to a few of our familiar garden-birds which, sharing our taste, consider fruit very palatable. Like ourselves, they do not by any means subsist wholly upon fruit, indeed, their depredations are frequently exaggerated. There is some excuse for the professional fruit-growers—men whose sole livelihood depends upon the success of their crops—to take steps from time to time to thin out the numbers of blackbirds, thrushes, and starlings, when these fruit marauders get the upper hand, but here again purely destructive measures when adopted may not always succeed. It has been shown in some cases that after a wholesale slaughter, say of a thousand blackbirds, the birds soon become more numerous than ever, which sounds as though the old saying were true of blackbirds as of flies that if you kill one, twenty come to the funeral. The blackbird is an abundant bird, and its numbers are augmented by thousands of immigrants from the continent, so that acres of ripe, juicy fruit will soon attract fresh invasions in lieu of the slain. It has been suggested that a scaring machine might prove more effectual than the gun. It is obvious that by adopting this measure loss of life would be mitigated, and in that way a larger population of blackbirds and other fruit-loving birds would be spared to carry out their useful work during the remainder and greater part of the year, when they destroy countless numbers of noxious grubs and other agricultural and garden-pests.



THE SPOTTED FLYCATCHER.

This bird is an abundant and widely-distributed summer-resident in our isles. Roughly speaking, a pair of flycatchers will destroy 2,500 flies in a week, and probably more.

In our private gardens, especially when they are well stocked with fruit trees, there is little to be gained and, for bird lovers, much to be lost in shooting a pair or two of bullfinches the moment these lovely creatures appear on the scene to pay us a very short annual visit. It is perfectly true that our fruit buds are actively raided, but there are other ways of checking our delightful visitors without taking their lives. Stay in your garden for a while, approach the birds closely, and they will soon pass on to another tree, follow them and they will select another tree. Keep moving and they will flit from tree to tree and nicely prune the quota of expectant fruit which later on, when half-grown, demand thinning out by the gardener. There are always more apple-buds in an orchard than can ripen. Look at the quantities of unripe fruit which fall, when too thick, if a breeze rises. Lastly, when the fruit has ripened look at the plethora of wasted apples lying at the foot of the tree. Surely many bird-lovers would give away scores of apples for the sake of the honeymoon spring visit of the beautiful affectionate bullfinches. As a benefactor to man, the bullfinch destroys a very appreciable amount of insects and their larva, on which it feeds its newly-hatched offspring. In autumn and winter, the seeds of dock, chickweed, grounsel, and dandelion, are consumed in great quantities.

The economic value of purely insectivorous birds is enormous. Statistics are often distasteful; here one or two will prove interesting: a great titmouse brought food to its young 384 times in the day, 90 per cent. of the food consisting of harmful grubs or caterpillars, so that when rearing the young it would be responsible for the destruction of 8,000 to 9,000 insects, chiefly caterpillars. My own records, for several of our common species, show that young birds are fed on an average every three minutes. Roughly speaking a pair of fly-catchers will destroy 2,500 flies a week, and probably more. Wagtails, pipits, warblers, and hosts of others, make the same clearance. The amount of food in the aggregate which a bird will consume in the day is prodigious, amounting to one-sixth of its own weight. Young birds eat food amounting to their own weight in twenty-four hours! A young robin can demolish fourteen feet of worm in twelve hours, and more if it be brought to it! In conclusion let me say that it cannot be too strongly urged that insectivorous birds are largely instrumental in maintaining the food-production of our isles.

The Temple of the Warriors.

American Excavations in Yucatan.

The following report of work which the Carnegie Institution is now undertaking in Yucatan describes the discoveries of the season just brought to a close. Among the plans foreshadowed for 1928 is the repair of an astronomical observatory, the oldest structure of its kind in Central America.

THREE working seasons ago the Temple of the Warriors, Chichen Itzá, Yucatan, to the eye of the casual observer, seemed nothing more than a tree-covered mound of debris rising fifty feet above a heavily-wooded plain. To-day, as a result of the work of the archaeologists of the Carnegie Institution of Washington, this sanctuary of Kukulcan, the patron deity of Chichen Itzá, gives visible proof of ancient magnificence. It is now clear that the Temple of the Warriors is by far the most elaborately decorated building at Chichen Itzá, once the capital of the New Maya empire, which contained a great number of imposing structures. It is also evident that it is one of the most beautiful examples of Maya architecture extant.

BEGINNING THE EXCAVATIONS.
The site of the Temple as it appeared two years ago. Workmen are seen beginning operations on the mound in which the structure was buried.

For centuries the splendid limestone structures of the greatest of America's aboriginal races have been assailed by nature's relentless forces. Wind and rain have beaten upon them, roots of giant trees have riven roofs and walls. As a result most of the formerly magnificent buildings have been reduced to huge piles of fallen masonry. The task of the archaeologist, attempting to repair these structures, consists of clearing these mounds of trees and underbrush, digging out and identifying the fallen structural elements, and returning them to their original positions. This replacement work on the Temple of the Warriors has now gone about as far as it is possible to carry it with the certainty that it faithfully conforms to the structure as it originally stood.

The Temple proper rests upon a pyramidal foundation 37 feet high and 136 feet square at the base. The hearting of the pyramid is of masonry and is faced with cut or dressed stone, the pyramid foundation rising in four retreating terraces. Each of the vertical parts of these terraces, except the uppermost part, carries a richly sculptured frieze consisting of eagles, jaguars, warriors, and an unknown quadruped which the Institution's archaeologists, for want of a better name, have called "the wooly." The design of the friezes comprises a repetition of alternating pairs of warriors and pairs of bird or animal figures.

The figures of the warriors are placed feet to feet, their faces turned away from each other. In general the bird and animal figures have their backs towards each other, while they hold what appear to be human hearts in their claws or forepaws. They seem to be offering these to the warriors whom they face. The warrior figures themselves wear elaborate costumes that still bear traces of the blue, red, and green paint with which they were originally decorated. Staffs or javelins from which plumes descend in long and graceful curves are held in their hands.

A steep stairway, 34 feet wide, containing thirty-six stone steps, ascends the front or west face of the pyramid, at an angle of 66 degrees with the horizontal. Two stone balustrades four feet wide, carved to represent feathered rattle-snakes, rattles at the bottom, fanged heads at the top, flank the stairway. Mounting this one reaches a broad terrace directly fronting the temple portal. Two massive feathered serpent columns, with heads on ground and tufted tail-rattles rising fifteen feet above, divide the temple entrance into a triple doorway.

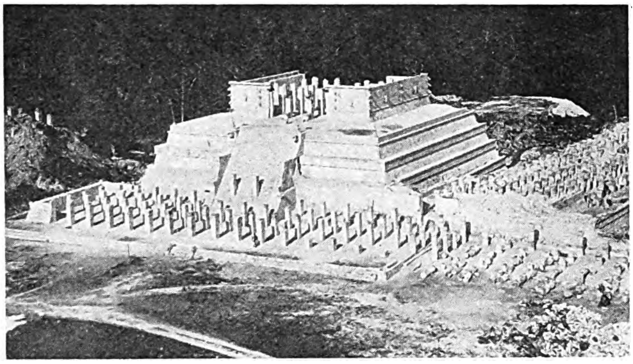
In front of this awe-inspiring entrance is a reclining human figure, life-size, carved in limestone. Such figures are known as Chac Mools, one of the minor Toltec deities. They are always represented as of human form reclining on back and elbows, with knees drawn up, arms pressed tightly to sides, and uplifted

head turned to one side. The abdomen is always flattened or hollowed out, presumably to serve as a receptacle for incense and other offerings.

Passing through this doorway, one enters a spacious hall, 60 feet long, 31 feet wide, and originally probably 22 feet or even more in height. Its corbelled-arch roof is supported by twelve square columns, each sculptured and painted with figures of warriors. This hall gives access, through a carved doorway in its rear wall, to the sanctuary of a temple of the same size as the outer chamber, its roof being upheld by eight square sculptured and painted columns. Against the back wall of the sanctuary is a platform, whether altar or throne has not yet been determined, some 14 feet wide, 8 feet deep, and 2 feet 8 inches high, resting on nineteen painted statuettes, carved in the likeness of human beings. The walls of both the outer hall and this inner sanctuary were originally covered with fine white plaster and then brilliantly painted with scenes of domestic life, of battlefields, and of religious ceremonies. These wall pictures have now been copied, wherever sufficient traces of the original were able to be distinguished.

But this was not all that the Institution's archaeologists found buried in the great mound of debris which concealed this splendid temple. During the first season of work (1925) Mr. E. H. Morris, who was in charge of the excavations at Chichen Itzá, found a square sculptured column buried in the north-west corner of the pyramid, 17 feet below the floor level of the Temple of the Warriors. He surmised then that some earlier building had been dismantled, and filled in to make way for the later and larger construction.

During the 1926 field season this conjecture became a certainty. Excavations in the north-west corner of the pyramid in front of this sculptured column disclosed two other carved columns lying in line with the first. These still preserved their original brilliant hues—reds, yellows, greens, blues, and blacks. Just in front, dismantled and broken, lay the enormous heads and tufted tails of the two great serpent columns which had formerly guarded the portal of this earlier temple. Never before have such colours been seen at Chichen Itzá. It was obvious at a glance that this older temple had been dismantled and buried in the masonry of the pyramid which supports the later Temple of the Warriors, while the paint on it was still fresh and vivid. Because the light of day had not reached it for centuries, perhaps for as many as six, its pigments apparently have been preserved at the highest point of their original brilliancy.



THE TEMPLE OF THE WARRIORS.

One of the most beautiful examples of Maya architecture yet discovered is seen here at the close of the 1927 working season, nearing complete restoration.

DECORATED FRIEZE ON THE PYRAMID FOUNDATION.

The sides of the retreating terraces seen in the upper photograph are faced with stone, decorated to represent eagles, jaguars and other creatures.

The final excavation of this buried temple was one of the principal activities at Chichen Itzá during the season just brought to a close. The results exceeded the archaeologists' fondest hopes. The Chac Mool figure belonging to this earlier temple was found lying on its back at the southern end of the outer chamber. Except for a broken nose and a broken lock of hair it was in excellent condition. The carving, protected as it has been from weathering, was practically in a perfect state of preservation. The eyes and fingernails would seem to have been made of some sort of an inlay, jade, shell, or obsidian, which, however, had been picked out in ancient times, before the figure had been walled up in this earlier temple.

The walls of the buried temple were brilliantly painted with enormous writhing serpents, while in two places on the wall plaster some idle hand had scratched the outline of a human figure, arms above the head, palms up, as if supporting something. Perhaps this was a study for the Atlantean columns upon which rested the throne or dais that once projected from the back wall. This

throne was completely destroyed when the temple was originally dismantled and the Atlantean figures carried away. There are grounds for believing that they were re-used in the Temple of the Warriors: the nineteen Atlantean figures supporting the throne in the newer structure were too tall for the positions they occupy, so they were buried up to their knees, below the floor level of the Temple of the Warriors. Little dummy feet of stucco were built out from the knees to give the effect that they were standing on the temple floor.

In the sanctuary of this buried temple a sculptured and painted column was found which in brilliance exceeds anything hitherto unearthed in the Maya area. The figure on the column holds a round fan in its hand. Delicate details of costume—embroidery, feather-work, tassels, as well as parts of the body, nails, hair, etc.—are clearly brought out by outline in black against brilliant colours. The amazing effect thus gained is barbaric in its splendour.

Dr. Sylvanus G. Morley, in charge of the Institution's activities in Yucatan, states that it was found that this earlier temple was roofed over and enclosed by the masonry filling of the pyramid, of which it was a part, in such a way that the original structure was preserved.

The excavation and repair of the Temple of the Warriors is but one of several Maya operations upon which the Carnegie Institution is working. Extensive excavations are being made in a still more ancient part of Chichen Itzá in an attempt to trace the course of the architectural development of the city. Work is going forward also on the repair of the Caracol or Astronomical Observatory, the oldest structure of its kind in the New World. It is hoped that 1928 will see the completion of this undertaking. Expeditions have also been made to distant regions where new Maya ruins have been discovered and examined. Dr. Morley reports that relations of the utmost friendliness and cordiality have been maintained throughout with the Mexican officials under whose jurisdiction the Institution is carrying on this work. A spirit of co-operation and of mutual assistance has developed which will have far-reaching effects in the development of this rich field of archaeological science.

A Steel Furnace in a Wooden Box.

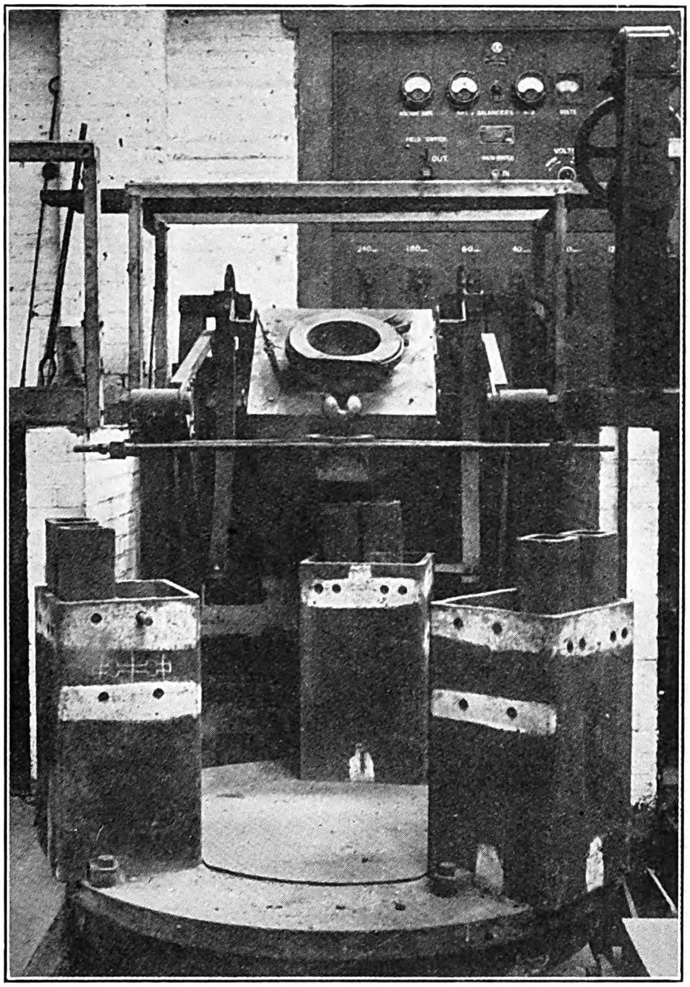
A development of unusual interest in steel-making was inaugurated last month at Sheffield, when the first high-frequency electric furnace to be used for the purpose was demonstrated to the Press. A special representative of DISCOVERY *who attended here describes the new process.*

THE sun shone through the haze over the city on the 6th December, when a party of a hundred guests arrived at the Imperial Steel Works, Sheffield, to witness a new process, perhaps itself prophetic of a smokeless future for industry. The occasion was the formal inauguration of the Ajax-Northrup high-frequency furnace, the first of its kind in the world to be used commercially for the manufacture of high quality tool steel, which has recently been installed by Edgar Allen and Co.

The ordinary electric furnaces hitherto employed have been used in this country for melting steel for about nineteen years. The first to be erected were of the induction type, but these did not prove satisfactory for British conditions and have long ago been abandoned. Arc furnaces, especially those which are not complicated by the use of bottom electrodes, avoid many difficulties. They are, as far as possible, designed so as to conform with standard basic open hearth practice, except that the source of heat is electricity instead of gas. The men operating this type require no knowledge of electricity, as it is simple and, mechanically, as robust as possible. In view of the new development, it is interesting to recall that the firm responsible for the latest design had, in 1909, put down the first electric arc furnace of a commercial size to be installed in England. Further, the designs for this original Héroult furnace had been made by Mr. D. F. Campbell, chairman of the Electric Furnace Co., which has now designed and supplied the new high-frequency type.

There was no catch in it!—there it stood, a square wooden box, so cool that one could touch it, yet containing inside it a crucible of molten steel. At a given moment, the wooden box was tilted and its glowing contents poured out into the mould prepared. To describe the process briefly, the steel is melted by a high-frequency alternating current, which circles round the crucible and induces eddy currents in the 450 lbs. of metal it contains. These currents are of such magnitude that the metal rapidly becomes molten, the whole process, from beginning to end, taking about an hour. Except for the low humming of the electric generators from the machinery room

hidden away behind the control board, there was no noise, and the whole seemed vastly different from the older crucible furnace which it replaces. In this, a number of clay pots or crucibles were heated up by coke or gas fires, each pot containing about 60 lbs. of steel. When the steel inside these pots was ready to be poured out or "teemed," a powerful workman stood astride the open furnace, enduring its fierce heat, and drew out the pots by means of special long tongs and his own muscular strength. Other workers single-handed lifted these pots from the ground with the tongs and poured their contents into the ingot mould, the amount of physical force required being enormous.



THE AJAX-NORTHRUP ELECTRIC FURNACE.
The rim of the crucible is seen protruding from the wooden box (centre), while three vertical moulds ready for the molten metal are on the turntable in the foreground.

In the new high-frequency apparatus, the steel is contained in a refractory crucible, or "pot," which is surrounded externally by about an inch of heat-insulating sand. Round this a water-cooled coil is wound, which carries a high-frequency alternating current of electricity, and without any contact between the coil and the steel, heat is generated or "induced" in the metal inside the crucible by means of this current. The walls of the crucible merely serve the purpose of a container, and no heat is passed from the outside of the crucible to the metal within. This is an important point which will be dealt with later.

The new Ajax-Northrup design had been employed in America for preparing nickel silver, but has never previously been adapted to high-grade steel on a commercial scale. Apart from observing its more obvious advantages over the ordinary crucible process —which, incidentally, has persisted with only minor modifications for nearly two hundred years—one was able at the demonstration to obtain some details of the cost of operation. The estimate that the cost per ton of steel produced will be lower, must admittedly remain an assumption until the furnace has been running for some time, but the price of current, about £2 1s. per ton, appears to be approximately the same as in the ordinary small electric arc furnace. While the initial capital outlay is heavy, the new process has the advantage that the space required is much smaller than that for plant and buildings needed to produce an equal amount of tool steel by the old crucible method, whether using a gas-fired or coke-fired furnace. The strictly technical advantages must also have a beneficial effect on cost.

The first of these concerns the purity of the steel produced by its means. As there is no contact with fuel, the gases given off by coke, do not penetrate and the steel is remarkably free from its deadliest enemies—sulphur, phosphorus, etc. Secondly, ingots of steel required to conform to a special analysis can be made very quickly, although it must be pointed out that the furnace is purely for melting and not for refining. Thirdly, there is a violent stirring of the metal electrically, the action being so strong that the surface of the metal in the middle of the pot is about one inch higher than it is at the sides. This ensures a very thorough mixing, so that if, for instance, a high speed steel is being made, the tungsten contained in it is evenly disseminated through the whole of the steel. Great homogeneity of the steel is ensured when making large ingots, such ingots having to be cast by the old crucible process from the contents of several crucibles, whereas in the new furnace, the full heat is cast from

the one pot. Lastly, the final temperature of the molten metal can be more closely controlled, while this furnace can be operated intermittently with very little loss and the use of heat guaged in a way that was hitherto impractical.

This point was dealt with by Professor C. H. Desch, D.Sc., F.R.S., in a speech at the luncheon that followed the works visit. The older induction furnaces, he said, were cumbrous appliances of lower efficiency. In the new design, the current consumed was remarkably low, as the heat was generated exactly where it was wanted and waste was thus eliminated. In mentioning that the metallurgical department of Sheffield University had previously had the first experimental high-frequency furnace in the country, he went on to illustrate the efficiency of the method. The capacity of the model was, smaller, only 12 lb., but the lid of the crucible had actually been removed with the fingers, at the point when the metal it contained had just become molten. The crucible was always cooler than the metal it contained, owing to the heat depending on induction in the metal itself. "I believe," Dr. Desch concluded, "that the new furnace has a very decided future as an implement of the greatest value to the steel-maker."

The characteristics dealt with were borne out by the demonstration, when the molten metal was poured out into the vertical mould without even marking the wooden box container; this had, of course, been arranged to illustrate the heat efficiency, and was not in practice a necessary part of the furnace.

The late Sir Arthur Shipley.

Professor E. W. MacBride sends the following account of the scientific aspects of the late Sir Arthur Shipley's career, which was reviewed from another angle in an editorial appreciation last November.

I FIRST made the acquaintance of Sir Arthur Shipley (then plain Mr. Shipley of Christ's) in the autumn of the year 1888, when I entered Cambridge as an undergraduate. He was then the demonstrator of comparative anatomy, and he gave me my first instruction in practical invertebrate zoology. Later I attended during two years his lectures on advanced zoology. After I had taken my degree in 1891 I proceeded to Naples, and on my return to Cambridge in 1892 I was appointed demonstrator in animal morphology, and became for a brief period Shipley's colleague. In 1893 Shipley and his close friend Harmer (now Sir Sidney Harmer, F.R.S.), undertook the task of editing the *Cambridge Natural History*, a most comprehensive work which was eventually completed in ten volumes, the publication of which extended over a period of nearly twenty years. The compilation of this work was one of the most valuable services rendered to the science of zoology, as it codified our knowledge of the habits and structure of all the phyla of the animal kingdom, and it was presented in readable form, abundantly illustrated. Shipley contributed articles on the groups in which he was specially interested, *viz.*, the Nematode worms, the Brachiopoda, the smaller groups of the Arachnida, and the Gephyrea. His articles are models of clear exposition. To-day, thirty years after the publication of the article on the Nematoda, I find that it still forms a most invaluable foundation for our knowledge of the group, and one to which I have constantly to refer.

In 1893 Shipley published his textbook of the anatomy of the Invertebrata. It was a most valuable book, and exemplified his grasp of really important facts and his sense of the necessity for brevity, clearness, and the exclusion of irrelevant detail. At the time of its publication the textbooks available for students were large, diffuse, and cumbered with an enormous accumulation of structural details which no student could properly memorize and which were calculated to leave in his mind the impression that the science of zoology consisted of a vast mass of undigested facts. In 1896, at his request, I collaborated with him in the preparation of a new textbook of zoology which included the vertebrates as well as the invertebrates, and the first edition of which was published in 1901. Shipley began his researches at a time when the great school of comparative embryology founded by F. M. Balfour at Cambridge was still in the first flush of its glory. At that time, to use words applied to another revolutionary epoch, what joy it was to be alive, what a heaven to be still young! Whilst Sedgwick was carrying out his epoch-making researches on Peripatus, and Bateson was startling the world by proving that Balanoglossus was a link between vertebrata and invertebrata, and Harmer was introducing us to the marvellous antics of the developing Polyzoon, Shipley began to work at the development of the lowest fish, the lampreys. During the course of this research he recognized and emphasized some points of fundamental importance in the understanding of vertebrate anatomy. He showed that the cavity of the heart, and inferentially therefore of all the other blood-vessels, was merely a remnant of the primitive segmentation cavity of the egg. He also showed that the repetition of muscle segments (myotomes) and of gill slits were entirely independent phenomena, and that the "segmentation" of vertebrata had no relation to that of "worms," as the then popular theory of the evolution of vertebrata presupposed. This clear-sightedness leads us to regret that Shipley did not persevere in his study of the vertebrata. But his heart lay in other fields. He was possessed with the strong desire "to tidy up" obscure and little understood corners of the animal kingdom, so he began to investigate the anatomy of the Gephyrea. I have still the notes of his lectures on this curious group of "worms"; they are as clear and informing to-day as when they were written. He investigated the anatomy of the Nematoda and of the curious Arthropod group the Pentastomida, and he made some pioneering researches on the development of the Brachiopoda. One reason for this choice of subjects of research was that Shipley saw with a clarity denied to some of his Cambridge contemporaries, that the original enthusiasm for evolutionary research would inevitably slacken and that it was of the highest importance to direct attention to animals which were of economic importance, even if that importance was due to their depredations as pests. His further services—developed after I left Cambridge—in building up a school of economic biology, and in organizing the opportunities for the employment of Cambridge biologists in other capacities than that of professors and teachers, came to fruition whilst I was in Canada, but to do justice to them would lead us outside the scope of this article.

A Defence of Stefansson's Discoveries.

By George H. Wilkins.

Leader of the Arctic Airplane Expedition.

The following details of the "blond Eskimo" and other discoveries have been received in support of Stefansson, "whose veracity more than his method of Arctic travel has been attacked in Amundsen's recently published autobiography." Captain Wilkins accompanied Stefansson on the journey under discussion, and we gladly publish his statement not to promote controversy but in the interests of polar research.

In Roald Amundsen's autobiography, entitled "My Life as an Explorer," there is the following statement:

"My experience leads me to believe that the two famous 'discoveries' of Vilhjalmur Stefansson should be taken with many grains of salt. I refer respectively to Stefansson's widely heralded 'Blond Eskimos' and to his equally famous 'Friendly Arctic.'

The Blond Eskimo.

"To deal with the 'Blond Eskimos' first. It is, of course, not beyond the bounds of possibility that some small tribe of Eskimos might have escaped the observation of white men heretofore, but to say that this is likely is to stretch the possibilities much too far. Such statements should be supported by positive proof, and I have heard of no such proof. . . .

"Stefansson's 'Blond Eskimos,' it seems to me, is simply a far-fetched idea. His 'Friendly Arctic,' however, is likely to give dangerous ideas to inexperienced explorers. No gullible person will come to any harm by believing that some Eskimos are blond. But it is entirely possible that some adventurous spirits, seeking a fresh thrill in the North, may be misled by this talk about the 'friendliness' of the Arctic, and will actually attempt to take advantage of this 'friendliness,' and venture into those regions equipped only with a gun and some ammunition. If they do, certain death awaits them. In my opinion, based on long experience and careful study, even a good marksman cannot 'live off the country' in the Arctic. It is conceivable, I suppose, that a very skilful and experienced explorer, in extraordinarily favourable circumstances, with weather and game conditions just right, and close to solid land, might for a very short time 'live off the country,' but I would not try it myself. I would consider it sheer suicide. I do not believe it can be done." (pp. 227-228)

In an edition of the book, written in Amundsen's native language, he makes his meaning more clear. A skilful translation from the Norwegian reads:—

"Stories of the polar regions must be read in the light of the explorer's previous career. I have written the preceding section (about Peary and Cook) partly to make it clear why it is that I always characterize the first of Vilhjalmur Stefansson's famous 'discoveries' as about the most unmitigated nonsense that ever has come out of the North, and his second not merely as nonsense but in addition the most harmful and dangerous nonsense. I refer to his widely circulated book, 'The Blond Eskimos,' and his also similarly famous, 'The Friendly Arctic.' . . .

"Stefansson's yarn about a special race of blond Eskimos deserves no more serious consideration than a sensational piece of news in a yellow journal. Stefansson's 'Blond Eskimos' are merely an amusing produce of his imagination. 'The Friendly Arctic' is, on the other hand, a dangerous misrepresentation of the real conditions. No gullible person will come to harm through believing that some Eskimos are blond. But it is entirely possible that some adventurous spirits, seeking a fresh thrill in the North, may be misled by his babble about the 'friendliness' up there, and will actually try to do what Stefansson says he has done, namely, to go adventuring into these regions equipped only with guns and a little ammunition. If they do, certain death awaits them. Stefansson has never done it, in spite of the fact that he says he has. I am willing to stake my reputation as a polar explorer, will wager everything I own, that if Stefansson were to try it he would be dead within eight days counted from the day of starting, if only this experiment takes place on the polar ice, which constantly is adrift over the open sea."

These statements question two things: Whether it is possible to live by hunting on the Arctic sea-ice out of sight of land, and whether Stefansson has done the things he says he has done.

It was my privilege to be with Stefansson's Canadian Arctic Expedition at the start of the ice trip described in his "The Friendly Arctic" (commencing on page 142). I can verify Stefansson's figures as to the load at the start, and I have every reason to believe that his statement on page 163 is also correct.

Stefansson's diary shows that on 7th April he had full rations for three men for about thirty days and dog feed for forty days. 26th April—nineteen days

later—his diary records, "We were two hundred miles from Alaska. We had provisions for two weeks only and signs of game getting fewer every day." Up to that point they had been getting seals, but from there on, in their hurry to reach Banks Island, they saw few signs of game until 7th May. Still two hundred miles from land and when young ice barred their way, Stefansson saw a seal. On 13th May they saw many seals; two were killed, but they could not retrieve them. The dog feed by that time was finished. They had fed the dogs on boots, bearskins, and other bedding. The men were living on less than three-quarters of a pound of food per day. On 15th May, it had come to a show-down. They were practically without food; by calculation they had less than three pounds of edible food with them. They were still some hundred and twenty miles from the nearest point of land. By sheer necessity they stopped to hunt. They killed two seals and lost them, but retrieved the third. The seals they had killed between 7th and 15th May had sunk, but after securing one Stefansson learned that it is necessary to shoot seal through the brain in order that it may readily float; even so, some seals killed in the summer will sink. Once having discovered the method of killing there was apparently no trouble to provide the party of three men and six dogs with ample food.

Hunting on the Sea-ice.

It was not until 25th June—forty-one days later—that the party reached the shore. For a period of almost six weeks they had undoubtedly maintained themselves by hunting on the Arctic sea-ice, out of sight of land.

It was the 11th of September—eighty days after reaching land and one hundred and twenty-one days after the food supply had totalled three pounds—that Stefansson arrived at the schooner, "Mary Sachs," then wintering at Cape Kellett, Banks Island. Stefansson, Storkerson, Andreason, and their six dogs had come through safely and they were unquestionably fatter and appeared in better health and better fed than when I left them on the ice some six months before.

We have the corroborative evidence of five men—Storkerson, Andreason, Crawford, Johanson and McConnell—that Stefansson's food supply on 6th April did not exceed thirty day's full rations for three men. Even Amundsen must agree that there was no means of replenishing their store of civilized food.

Stefansson, Storkerson, and Andreason are alive to-day, after having maintained themselves for forty-one days by hunting on the sea-ice and for eighty days on Banks Island; a record clearly stated in Stefansson's book and which anyone can prove. Yet, in the face of this, Amundsen publishes a statement translated as follows:—"But it is entirely possible that some adventurous spirits, seeking a fresh thrill in the North, may be misled by his babble about the friendliness up there, and will actually try to do what Stefansson says he has done; namely, to go adventuring into these regions equipped only with guns and a little ammunition. If they do, certain death awaits them. Stefansson has never done it, in spite of the fact that he says he has."

Amundsen himself, in his book "Our Polar Flight" (on the Amundsen-Ellsworth 1925 Expedition by airplane), supplies evidence of having seen a seal within a hundred miles of the North Pole, and Lincoln Ellsworth, in his story of the transpolar flight, tells of having seen a bear's track in the vicinity of the Pole of Inaccessibility—some five hundred miles from land. But, whether or not seals in number and bears may be found further than two hundred miles from land; whether the policy of living off the country while engaged in scientific work in the Arctic is sound, is not the purport of this dictum.

It has been my privilege and pleasure to find in Stefansson a careful and accurate scientific observer, whose statements of fact have at times been misquoted and misrepresented in newspapers, but whose books, when carefully read, impart reliable information and tend in no way to mislead the public or adventurous spirits seeking knowledge of Arctic conditions.

Amundsen says "Stefansson's blond Eskimos are merely an amusing product of his imagination." I lived on Victoria Island with an Eskimo tribe, among which were two women, three girls, one boy, and a man with light brown hair, blue eyes, fair skin, and rosy cheeks. Some of these people assured me, through an interpreter, that they were old friends of Stefansson's. Other scientific observers who have seen some of these people are Diamond Jenness and Knud Rasmussen. There are many other reliable witnesses. There is no occasion to imagine "Blond Eskimo"; even casual travellers in the district they inhabit know they exist, although the origin of the blond characteristics is yet to be proved. Several scientific observers are inclined to agree with Stefansson's opinion that the blondness is due to the influence of Viking blood from Greenland.

Amundsen, in his book, implies that Stefansson is guilty of wilfully mis-stating facts. Let me assure Amundsen and the public that evidence fully supporting Stefansson's statements can be obtained from the six members of his expedition who are in possession of the facts.

Correspondence.

BROADCASTING AND MUSIC.

To the Editor of DISCOVERY.

SIR,

Among the many subjects that *Discovery* has introduced to notice within recent months, none are calculated to make a wider appeal than Mr. Edward Liveing's series on that new phenomenon which has emerged on our civilization as an agency in our social life of tremendous significance. Had Mr. Liveing been content to claim, in his introduction to "Invisible Music," that his article "is definitely that of a layman in music, but a music-lover," it would have been accepted and allowed to stand for what it is—a very agreeable and valuable essay on a widely popular and fascinating topic. But, when he continues and says "it is possible that a layman can look at some of the fundamental issues involved in the effect of broadcasting on music more neutrally than a musician," he invites a challenge on the very ground on which he claims immunity from the suspicion of bias or partiality—that of being neutral. For Mr. Liveing writes as something more than a mere layman; he is a servant of the British Broadcasting Corporation.

It is the broadcaster Mr. Liveing and not the layman Mr. Liveing who exclaims, "one can look forward to the day when broadcasting in all countries of the world will be the prime mover in musical life, *if, in fact, it is not already so to-day*" (the italics are mine). Our musical life is made up of more than music lovers and listeners; the real musician is the performer, the interpreter, and until broadcasting has produced the interpreter in addition to the listener it will not be possible for it to claim to be more than one factor making for progress. Indeed, the change being brought about may not spell progress. There are many things in broadcasting that cause us to speculate, but he would be a rash man indeed who, at this stage, were to say prophetically whether broadcasting is to aid in the coming of the musical millennium or is to threaten its disaster.

Surely it is also the broadcaster and not the layman who argues for invisibility by saying that "the very lack of visual images places the listener more closely in touch with the mind of the composer himself when he first conceived the music"? Here is a confusion and a fallacy. Besides which, it may be pointed out that Nature, without waiting for the marvellous adventitious aid of the broadcasting apparatus, has already provided a ready means of procuring invisibility in the performer. It is only necessary to resort to the simple expedient of closing the eyes or looking in another direction, to produce exactly the same effect as the broadcast performance. The confusion lies in the delusion that "the listener hears the melodies and harmonies as they first took their texture in the creator's mind." This merely restates the old fallacy that the notes are the music and the music is the notes. The disinterested layman in music, but a music-lover, will reply that he hears nothing else than what the interpreter pleases him to hear. No performer gives an interpretation to any but his own conceptions of what the composer has in mind. It matters not whence conceptions come. What he gives us is not "the music" but his idea of the music.

Then Mr. Liveing's views on opera, which make him suggest that "broadcast opera offers a satisfying alternative to stage productions" to those who regard opera as a hybrid art, are open to comment. The term "broadcast opera" is deliberately used more than once to distinguish it from the hybrid kind, but that does not shield him from the criticism that what the broadcast offers is not opera at all, but the music of the operatic composition. In the opera music is but one among several partners engaged in producing the total effect; poetry, scenery and action at once, and in combination, make clear the meaning of all that is done and sung. Therefore it is beside the question to talk of the constituents excepting music as "discordant elements," and special pleading to suggest that "broadcasting has come to keep the art form alive," when what is offered is not even a shadow of an abbreviated hybrid; only a limb or branch of the main body. All the most refined arts are called in to contribute to the opera idea, and inasmuch as "broadcast opera" is not representative of an art-form which rests not in music alone but in the visible beauties of action, as they may be expressed by the painting of scenery and the grouping of human figures, the credit of broadcasting in relation to opera which the Director of the Manchester Station, B.B.C., seeks, is one that cannot be allowed.

Yours faithfully,

Palmers Green, N. HERBERT H WARDLE.

13th December, 1927.

THE STONE AGE IN EAST AFRICA.

To the Editor of DISCOVERY.

SIR,

With reference to the strata in which Messrs. Leakey and Newsam discovered important Stone Age remains in Kenya, it is stated on p. 330 of your issue for October, that I am inclined to attribute "an even earlier dating to the deposits than is Mr. Leakey at present." This is not so; in fact, the exact opposite is true.

According to Mr. Leakey, Elmenteita cave-man, by which I mean the extinct race revealed by human remains at the bottom of the excavations in the Elmenteita cave, is pre-Riss in age, while according to my showing he cannot be older than Riss. Similarly, Mr. Leakey makes his Elmenteita B man Würm in age, while I regard him as post-Würm.

I have been working on the Stone Ages of Uganda at intervals for the last nine years, and one of the difficulties, which at last appears to be solved, is the disentanglement of the effects of earth-movements and pluvial periods, as recorded in the present disposition of terrace gravels. It may now be declared with considerable confidence that there is sound evidence of two pluvial periods in Uganda, and some evidence, not entirely conclusive, of a third. All of these fell within human times. In the Nakuru-Elmenteita area the issue is not fogged by tectonic effects, and the evidence appears to be plain. I have little doubt that the great pluvials were a climatic phenomenon of the Great Ice Age; but I feel less sure to-day than I did a few months ago that the "Third Pluvial" is one of these; I am rather inclined to regard it as a post-glacial event. Should this prove to be the case, it would seem that the dating of Mr. Leakey's finds must all be pushed forward one period. Clearly this is an important matter to decide.

Yours faithfully,

The Geological Survey of Uganda, E. J. WAYLAND.

Entebbe. *7th October*, 1927.

THE TRAVELS OF *DISCOVERY*.

Miss A. F. Bryant (Kings Langley, Herts.), writes to the Editor:—"It may interest you to know I send my copy on to (1) the British West Indies: (2) British Columbia; and sometimes (3) Tasmania."

Stageless Drama and Pageless Literature.

By Edward Liveing, M.A.

Manchester Station Director, British Broadcasting Corporation.

In a further vigorous article, Mr. Liveing outlines the factors that characterize broadcast plays as a distinct new art, of which the full significance has yet to be discovered. His previous contribution on music is discussed by a correspondent elsewhere this month.

SOME of the most interesting features of development in broadcasting are the revival of old art forms and the modification, or extension, of existing means of self-expression. While perhaps the social importance of broadcasting is more obvious in its religious services, talks, and news bulletins, the work which it is doing in apparently less significant channels will be found, sooner or later, to be exercising a profound effect on the literature and the drama of the day.

A New Art.

In the early days of broadcasting it was natural that the broadcaster should have turned to the existing traditions set up by his predecessors in the various forms used to express the currents of social life. Thus we find, for instance, that existing plays were adapted somewhat haphazardly to the wireless medium. Foreign broadcasting organizations have, in fact, paid very little attention to the potentialities of radio drama since their inception. The British organization, and to some extent the German, have very definitely appreciated the fact that radio drama is a new art form and that, while at the outset the adaptation of the traditions of the stage served useful purposes, the art is now essentially an art of its own. To the person who is not blessed with imagination, radio drama has nothing whatever to offer, but to him who can, in the words of the Prologue to Shakespeare's " King Henry the Fifth " :

> Piece out our imperfections with your thoughts,
> Into a thousand parts divide one man,
> And make imaginary puissance ;
> Think, when we talk of horses, that you see them
> Printing their proud hoofs i' the receiving earth ;
> For 'tis your thoughts that now must deck our kings,
> Carry them here and there, jumping o'er time,
> Turning the accomplishment of many years
> Into an hour-glass.

the broadcast play offers a reflection of life which could not otherwise be obtained. The auditorium is your room. Turn out the light and the fire becomes your footlights, while the darkness, stimulated by sound, offers a multitude of scenes which could never be portrayed on affairs of canvas and wood. By its very lack of scenery the radio play gains in the width of its dimensions. Like the cinema play, it can only appeal to one sense, but again like the cinema play, this very fact frees it to shift its heroes and heroines and characters from scene to scene and climax to climax in a way that is entirely denied to the stage play.

As I have pointed out, other broadcasting organizations in other countries have paid but scant attention to the development of this new form of art. In Great Britain it has been taken seriously both by listener and broadcaster. On the one hand, the technical apparatus needed for reproduction of background noises, and on the other hand the adaptation or special writing of the plays, have both made great progress. In particular, the plays that are now transmitted from the Head Office of the organization in London are dealt with technically in the most comprehensive and complicated manner, separate studios being used for actors, effects, orchestra, and artificial echo respectively, and the *ensemble* of noises from the studios being controlled by the producer and given their due proportions by him through the use of a special " mixer."

Present and Future.

From the ground which has already been gained, and the experiences that have accrued to us, it would appear as though there are two possible main lines of development in the present and future. The form of drama which has been strongly advocated by Gordon Lea in his very stimulating little book on " Radio Drama " is that of what he calls " the self-evolving play." In a play of this kind, the aid of the announcer or story-teller to introduce scenes and action is dispensed with altogether, the voices of the actors themselves informing the listener at the start of the play, or during its course, of its location, of the time, and of all other essential details. At the opening of such a play we would hear a girl character inquiring of a man character where he is in such words as " I am looking out of the window, but I cannot see where you are " ; to which the other character would reply, " That is not very likely, because I am trying to get the wireless aerial disentangled from the shrubs at the bottom of the

garden." This is, of course, simply a crude and elementary example of the methods that can be used. My own opinion is that, though this method is theoretically excellent, it is by no means practically sound, certainly not practically sound for long plays or plays of an episodic nature. The other line of development, and the one which I think is more likely to proceed successfully, is that of what might aptly be called the "illustrated wireless story." It finds its parallel quite definitely in the cinema play. The carefully written announcements of the story-teller, which enable the broadcaster and the listener to bridge over gaps of time and space, fulfil the same objects as the sub-titles of the cinema screen, introducing the audience to the first scene and subsequently to the other important scenes; the well-differentiated voices of the actors with the necessary noise effects produce the various scenes, and the introduction of music into certain of such plays or wireless stories at the proper moment provides the emotional background. The earliest crude experiments leading towards such a type of wireless programme were conducted in the United States, where radio versions of cinema plays were given in order to advertise these in advance. An experiment of this kind was made by the Manchester Station in 1926, when a broadcast version was given of the film-play, "The Greater Glory." Subsequently very remarkable progress has been made at London and other stations in the development of this art form, Cecil Lewis's adaptation of Conrad's novel "Lord Jim," and the adaptations of Shakespearean plays, being examples which may be specially cited. There is, to my mind, a great future for radio drama of this character.

MANCHESTER STATION REPERTORY PLAYERS.

In the scene here shown from "Independent Means," the players before the microphone are dressed in costume to help them obtain the stage atmosphere.

Many unexpected difficulties were encountered in the early days in regard to accurate reproduction of sounds and noises to illustrate plays. It was found, for instance, that a knock on a door by a human hand sounded more like a knock on a box and that a pistol shot entirely lost its actual piercing sound over the microphone. There are in fact very few noises which can be reproduced faithfully over the microphone and substitute noise-effects give a much more accurate sensation. Even were it possible to illustrate every wireless play, the action of which is placed near the sea, by putting a microphone down on the shore to relay the breaking of the waves, it would be found that this would in no wise be as satisfactory as the revolving of loose shot in a sieve. Through careful and continuous experiment apparatus has now been evolved to produce nearly every type of noise required in the average play.

What future is there for the wireless play-wright and the wireless actor? It is obvious that the immense fees paid to stage dramatists for plays which in most cases have long runs, cannot possibly be paid for only one or two performances rendered by a wireless organization. It has therefore been no easy matter to persuade well-known dramatists to write plays for the wireless or to have their plays adapted to this medium. This is a serious problem, but it is to be hoped that play-wrights of the future will recognize that, even though not so financially inviting as stage plays, wireless plays offer much freer scope for plots and even in some respects for characterization, and that their audience in this respect is nation-wide and world-wide rather than one held within the four walls of a theatre. So far, too, as English plays are concerned, copyrights of these can be sold not only in Great Britain, but also in the United States and in the several countries of the British Empire. At least it may be said that the wireless medium has made fame for more than one young play-wright, and that in at least one instance it has been responsible for a long play that has subsequently been reproduced on the stage, "The White Chateau."

And for actors, too, the wireless offers certain definite advantages. One of the most essential points in the presentation of wireless plays is the very careful differentiation between the voices of the various characters, since this is not only the guide to the listener to distinguish between the characters,

but also the means of bringing out the personalities in a cast to the fullest possible extent. Personality in voice is essential to the wireless actor; suitable appearance is not. Many well-known stage players are frequently employed and also many players who have not had great stage experience, but who seem to realize intuitively the fact that the voice is the one medium for conveying personality to the unseen audience, and that the wireless play is something which must give an impression to the listener that he is over-hearing events taking place somewhere or other in the lives of individuals outside the four walls of his room.

At the beginning of this article I said that broadcasting was responsible for reviving old art forms. Its incursions into literature make a good example to illustrate this statement. If we trace the origin of the novel to its earliest sources, we picture the ancient story-teller in the market-place or at the wayside, standing on an upturned box or large stone and using every trick, not only of gesture, but also of voice, to attract and to hold the attention of his audience. The wireless story-teller of to-day finds himself—or should find himself—in much the same position as that of his early predecessors. But he is robbed of all appeal through bodily or facial gesture; and he must fall back on making the fullest possible use of that wealth of stimulating properties possessed by the human voice. It is an unfortunate fact that bound and printed volumes have thrown so large a gulf between the ancient and the modern methods of story-telling and between the ancient and modern story-teller. If the wireless story-teller wishes to bring his story home to the heart of the listener, he is well advised to dictate it to a friend or a secretary first and to watch its effect in the course of delivery. If more attention were paid to simplicity of plot and presentation and less to ornateness of language, the appeal would be found to be much greater, and this without any loss of style. Ability to ring every change of emotion through voice inflections, and simplicity and forcefulness of style, are the essentials in the wireless story-teller's outfit.

The Wireless Novel?

The short story has come to stay in wireless programmes; but whether the wireless novel has any future in front of it remains to be seen. An abbreviated version of a novel by A. E. W. Mason was read nightly for a week over the broadcasting system of this country some year or so ago. One of the chief problems to be overcome in relation to wireless serials is the drawing up of a synopsis of such a nature that its length for the introduction of the final chapter is little greater than that employed for the introduction of the second. The whole idea is somewhat akin to the one-time "penny-readings," which certainly had a remarkable vogue in their day. Perhaps the running of such a feature over the microphone would bestow more benefits on the regular reader than on the regular listener, for it might quite possibly exercise a salutary effect on the verbosity of the average modern psychological novel. But the whole problem of serial narratives is one that may happily be shelved until the materialization of schemes for supplying alternative programmes to all listeners.

Possibilities of Poetry.

In passing to the subject of the broadcasting of poetry, I must admit personal uncertainties. Some months ago I regarded the possibilities of successful broadcasting of lyrical poetry as very shadowy indeed. To-day my doubt is not so definite and I think that, at the suitable moment and with the suitable reciter, the possibilities of success are considerable. Three factors must be taken into consideration:—(*a*) The lyric is the rapid expression of a surging mood; (*b*) That mood will almost certainly not be the mood of the majority of listeners when the poem is recited unless it has been carefully fostered by the preceding items, musical or otherwise, in a programme, or unless (a still better alternative) it fits in with an important occasion on which the social consciousness has been directed towards a certain goal of thought and feeling. An example would be the reading of one of Rupert Brooke's 1914 Sonnets in an Armistice Day programme; (*c*) As already emphasized in preceding articles, the appeal of broadcasting is to the individual to whom the approach must be intimate and friendly. Declamation of lyrical poetry as though to a large audience at once strikes an artificial note and is absolutely fatal. I need not point the obvious inferences to be drawn from these remarks. The broadcasting of narrative poems presents a considerably less difficult problem. Elasticity in voice inflection, enabling every dramatic point of the story to be brought out ot the full, clarity of diction, and a good imagination are the chief requirements of the wireless reciter of narrative poetry. In the course of time we may see the rise of a school of broadcasting poets, just as we may also see the rise of a school of composers of music for this medium. We are, as yet, only on the threshold of the temple. Developments in broadcasting follow closely on the steps of one another, and, as in all activities of life, ideas which appear far-fetched to-day become the institutions of to-morrow.

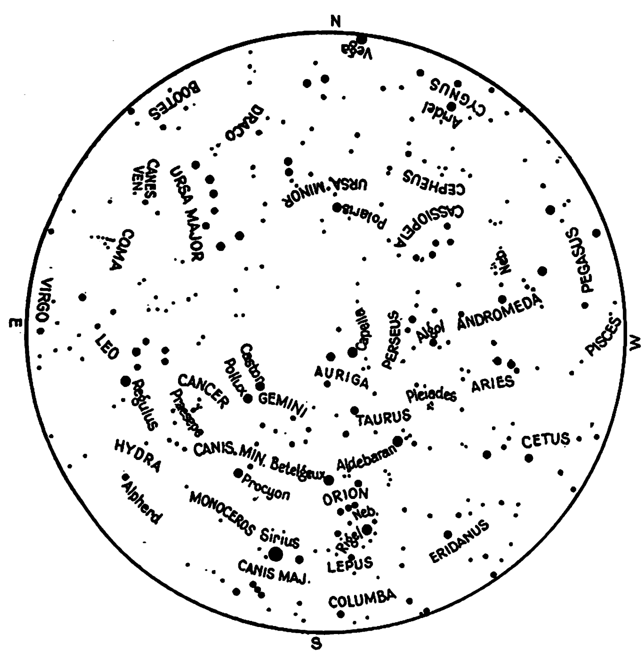
Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

Late of the Royal Observatory, Greenwich

THE FACE OF THE SKY FOR JANUARY.

THE star-map (for 6 h. sidereal) has the two equinoctial points on the eastern and western horizons, and the most northerly point of the ecliptic (the First Point of Cancer) due south; this point is in the feet of the Twins; it was close to it that Uranus was discovered in 1781. Jupiter has now passed out of the monthly map, but may still be observed in the early part of the night. Mercury may be seen as an evening star at the end of the month; it must be looked for as soon as possible after sunset. Neptune is very close to Regulus on the 8th; it will be interesting to trace its daily motion at that time. Encke's comet may be visible in moderate instruments when the moon is not up. The following ephemeris for 0 h. (that is, the midnight at the beginning of the day) is from the B.A.A. Handbook; 10th January, R.A. 22 h. 46.4 m., N.Decl. 3° 51′; 18th January 22 h. 51.2 m., N. 3° 45′; 26th January, 22 h. 54.7 m., N. 3° 16′. It must be looked for as soon as it is dark.



THE FACE OF THE SKY AS SEEN FROM LONDON at 6 hours sidereal time: that is, at 11 p.m. on 6th January; at 10 p.m. on 21st January.

New Comets.

A comet of the third magnitude, with a tail 3 degrees long, was discovered by Mr. J. F. Skjellerup at Melbourne on 3rd December; it was 54 degrees south of the equator, but was moving northward, so may become visible here. No further information can be given as yet. Ten comets have now been found during 1927; this number has only once been exceeded, in 1925, when eleven were found. Four of the ten were expected periodic comets; the other six were new, but one of them, discovered by Mr. W. F. Gale in Sydney, proves to be a short-period one (period about eleven years). A comet discovered at Bergedorf by Prof. Schwassmann and Dr. Wachmann on 15th November, seems to have a remarkable orbit; the values so far published indicate that it passed its perihelion one and a half years before discovery, and is now well outside Jupiter's orbit; its motion was, however, so slow that the orbit is still uncertain. It is not quite impossible that the comet discovered by Skjellerup (mentioned above) is identical with the one discovered by De Vico in 1846; this comet has been expected for some years. Skjellerup discovered several comets when he lived in South Africa, but this is his first since he went to Melbourne.

New Star in Taurus.

Besides their discovery of a comet, Prof. Schwassmann and Dr. Wachmann also discovered an interesting Nova in Taurus on 18th November, in R.A. 5 h. 15 m. 12 s., N.Decl. 16° 38′, magnitude 10. As it happened in previous discoveries of Novae, so in this, the immense stores of photographic plates at Harvard Observatory have added to our knowledge of the earlier history of the outbreak. Miss Cannon announces that previously to September last the star was invisible on the plates, and was not brighter than magnitude 15. It was first found on a plate of 11th September, when its magnitude was 11.7; its rise was less rapid than that of some Novae; on 25th September it was 8.2, and on 30th September it reached its maximum, which was 6.0. Its decline set in without delay, by 9th October it was 7.2, by 20th October, 7.6, by 4th November, 8.5 It was, therefore, a naked-eye star at the end of September, but at that time it was on the meridian at 5 a.m., so was outside the region that most observers explore. Its spectrum was photographed with the 24-inch reflector at Harvard on 20th November; the hydrogen lines were bright. The position, like that of most Novae, is quite close to the Milky Way, about 11 degrees from its central line. Other recent Novae in the same general region of the sky are those found in Gemini in 1903 and 1912, and that in Monoceros in 1918. The phenomena exhibited by Nova Pictoris are thought by most astronomers to indicate that the outbreak arises from internal rather than external agency, some unusual conditions causing abnormal heating, and consequent rapid expansion.

Jupiter Phenomena.

Mr. B. M. Peek and Rev. T. E. R. Phillips drew attention, at the November Meeting of the British Astronomical Association, to the interesting phenomena on Jupiter at the present apparition. There have been numerous small white spots on the equatorial belt, and these have shown a rate of motion intermediate between the equatorial rate, whose period is 9 hours 50 minutes, and that of the temperate zones, which is 5 minutes longer. Also the rate of these spots was found to

vary, as though they were gradually coming under the influence of a zone different from that of their origin.

Double Stars.

Those who are interested in this subject will find an important contribution to it in "Publications of the Yerkes Observatory," Vol. V, part i. This contains observations of about 3,000 doubles made with the great refractor by Prof. G. van Biesbroeck, who is a most diligent worker, since he has also been assiduous in observing comets during recent years. The stars selected for observation are naturally the more difficult pairs; in particular he has reobserved the binaries that were detected by Prof. Hussey about the beginning of the century; many of these show some change of position which enables an estimate to be made of their hypothetical parallaxes, and probable distance; such estimates are given in all cases where possible. There are also a number of newly computed orbits. The system 37 Pegasi is one where the orbit is turned edgewise to us, so that the motion is simply oscillation in a straight line. The period is found to be 150 years. 70 Ophiuchi is a star that has led many computers to deduce the existence of a third unseen companion from deviations between theory and observation; Prof. van Biesbroeck does not regard this hypothesis as necessary. He gives a new orbit of λ Ophiuchi, with a period of 150 years; but he has found it necessary to omit the observations of Sir W. Herschel of this star, as they seem to be affected by some error that cannot now be corrected. Double stars are the only means of determining the masses of the stars, and hence of verifying the important proposition reached on theoretical grounds by Prof. Eddington, that the "Absolute Magnitude," or total light emitted by a star ought simply to depend on its mass. A corollary of the theory is that stars turn a considerable portion of their matter into energy in the course of their career, so that their mass gradually diminishes.

Book Reviews.

The Earth: Its Nature and History. By EDWARD GREENLY, D.Sc., F.G.S. (Watts & Co. 1*s*.; or 7*d*. in paper covers).

Unlike many books, this little work (one of the "Forum" Series) by Dr. Greenly is exactly what its title leads one to expect: it deals clearly and concisely with the nature and history of the earth. In fifty-four small pages we have an account of the materials of which the earth is composed, of the manner in which they were formed, and of the changes in character and in situation which they have undergone. This is followed by a description of the processes by which the present surface features of the earth have been developed, and by a brief resumé of the history of the living things it has supported. Geological structures and the relation which exists between rocks and scenery are adequately illustrated by means of a few well-chosen, clearly drawn, and lucidly described sections.

Although it covers essentially similar ground, the present work is not a textbook of geology; it is, rather, an epitome in simple language of the contents of such a textbook, and it is intended, as the author states in his prefatory notes, "for the general reader who desires to know something of what has been ascertained by Geology concerning the nature and history of the Earth, and of the methods by which that knowledge has been acquired." That was the author's aim, and he has successfully accomplished his task, for the vivid word-pictures he gives of the operations of the rock-forming and rock-destroying processes cannot fail to appeal to any intelligent reader; but in addition to that, the book should appeal to the student and to the trained geologist, because of the admirable way in which it summarizes the aim and scope of geology.

A very useful feature is an appendix with suggestions for further study; in addition to references to works on geology, it contains the very practical suggestion that museum collections should be consulted in order to enable the reader to make himself acquainted with the significance of the mineral and rock names which so frequently occur in geological literature, and it reminds the reader that neither books nor museums can take the place of "what we see along the countryside and under the open sky."

The book is obviously the work of an outdoor geologist—one who has studied the rocks as carefully in the field as in the laboratory—and as such it combines two qualities not usually found in a single book. Not only is it a book for the fireside, but as a running commentary upon natural features it is an excellent travelling companion. This is probably to be explained by the fact that Dr. Greenly has spent all his working life as a student of outdoor geology; after some years with the Geological Survey, he took up the study of the rocks of Anglesey and the adjacent part of Caernarvonshire, and for a quarter of a century devoted his whole time to that work, in which the late Mrs. Greenly played no small part.

The little book is well produced, and in stiff covers at a shilling is very cheap. It would be greatly improved by the addition of a few plates illustrating some of the earth's surface features and the operation of the processes by which rocks have been made and have been destroyed, and the desirability of issuing an illustrated edition at a higher price is worth serious consideration.

F. J. NORTH.

An Outline of Stellar Astronomy. By PETER DOIG, F.R.A.S. (The Draughtsman Publishing Co. 7*s*. 6*d*.).

The author, Mr. Peter Doig, is well-known to astronomers for his valuable researches on the motions and distribution of the stars, and other matters connected with statistical astronomy, and in this little book he has written an authoritative summary of our present knowledge of the stars. The work is not for the absolute beginner, for it assumes a certain acquaintance with the fundamental facts and definitions of astronomy. Those who already possess a working knowledge of the science will, however, find the book extremely interesting, and will find themselves constantly referring to it.

The book is divided into three sections, of which the first deals with "The Individual Star—Observational Data." In the first chapter of this section are discussed such matters as the dimensions of the stars, their luminosities, masses, densities, etc. Chapter II deals with the movements of the stars, their distribution in space, and their numbers. Chapter III gives an account of double stars, variable stars, and "novae" or temporary stars, with their associated phenomena. The second section is concerned with the nature of a star, its surface and surroundings, the conditions that obtain inside a star, and the course of stellar evolution Much of the matter dealt with here is so recent that any hypotheses built upon it can

as yet only be regarded as tentative. Where two theories clash, the author in true scientific spirit is careful to present both sides of the argument. The theory of " Giant and Dwarf " stars is very competently handled, Mr. Doig having made this a subject of special study. As most readers will know, he was responsible for the splendid chapter on the same subject in " The Splendour of the Heavens." Section III is devoted to " The Stellar Universe," our own special system, or Galaxy, being deftly treated in the first chapter, while the second chapter is occupied with " External Systems " or Island Universes, as they are occasionally called. A valuable feature of the book is the full list of references appended to each chapter, which will enable the reader to check the statements in the book, and also to extend his studies in any required direction. There is also a series of appendices, consisting mainly of an explanation of the various mathematical formulae employed in astro-physics, with examples of their application. The illustrations, if not numerous, are good, though the fact that they were reproduced through a rather coarse screen has resulted in a slight loss of detail. We have no hesitation, however, in recommending the work to every student of the progress of astronomy.

J. A. Lloyd.

Art in Greece. By A. de Ridder and W. Deonna. " History of Civilization Series." (Kegan Paul. 21*s.*).

" How is it that, wherever Greek products have gone, Greek art has modified age-old traditions, leading all, from one side of the world to the other—Indians and Gallo-Romans alike—to the understanding of an ideal so different from their own? Was this the result of historical hazard, of circumstances external to Greek art? No, it was due to its innate qualities, to its amazing aesthetic and technical superiority." In these sentences from M. Deonna's concluding chapter is indicated the dual cause of the permanent importance of Greek art, its intrinsic excellence on the one hand and its kindling quality on the other. By the former it has given a standard of achievement in artistic matters for all time; from the latter it comes to pass that contact with Greek art has ever meant a quickening of the aesthetic faculties and a stimulus to the production of works of art. The treatment of the subject in this volume is intimately linked with the purpose of the series as a whole, to which all students of man's civilization are deeply indebted. Greek art is studied in relation to the social and political development of the Greek people, as expressing " the collective soul of the people, its aims and its aspirations."

Accordingly the increased individualism and the gradual decline of the idealism of fifth-century Greek art, which begin to be observed in the fourth century, and reach their full effect in Hellenistic and Imperial times, are related to the changing social conditions in a Greece where the citizen no longer held political power, and cosmopolitan influences were increasingly felt.

Similarly in tracing the growth of Greek art up to the masterpieces of the great period, an attempt is made to distinguish the influence of the main ethnic groups of the Greek people, and in Attic art is found the reconciliation of the excessive softness of the Ionians and the too great severity of Doric work.

The technical problems which faced the Greek artist in his progress from primitive conventions to a free expression in his material are excellently dealt with. By his sense of reality and his progressive study of anatomy, the Greek cast off the fetters by which other ancient peoples mostly remained bound in their plastic arts. The stiff frontal postures gave place in a surprisingly short period to free naturalistic figures. The steps by which this freedom was achieved, and the rhythms which may be detected in single figures and in the composition of metope and pediment, the Greek treatment of drapery and of anatomical detail are all well illustrated by a series of diagrammatic figures. M. Deonna has admirably completed the work originally entrusted to M. de Ridder, whose three chapters, all that was finished before his death, form an introduction to the volume. In that introduction M. de Ridder disclaimed the intention of writing a history of Greek art, which is indeed precluded by the compass of the work, or a philosophy of Greek art, and the book as completed has something of the qualities of both, and forms a valuable introduction to the study of the artistic achievements of Greece, both to the student of Greek life and to the student of aesthetics. The latter will find much to interest him in the foreword of M. Henri Berr, who discusses the function of art in human life. In a work which draws its illustrations from so wide a field as architecture, sculpture, vase painting, and figurines, many questions must be treated in a rather summary fashion, but footnotes supply constant references to the bibliography of over two hundred volumes, which is not the least valuable feature of the book, and will enable the reader to follow up any aspect of the subject in which he is interested. Apart from some sixty figures in the text, the book is illustrated by twenty-four plates, but in some of them (*e.g.*, XX and XXI) the dark technique of the process obscures the detail of the figure, and the reviewer prefers the lighter plates of the original French edition. The translation is a very competent one.

G. F. Forsey.

Astronomy. By H. N. Russell, R. S. Dugan, and J. Q. Stewart. (Ginn & Co. Two Volumes. 10*s.* 6*d.* each).

This excellent book hails from America, and is called a " revision of Young's ' Manual of Astronomy '," but the revision has been carried out so thoroughly that practically a new work has been produced. Three astronomers of the Princeton University Observatory, each a noted expert in his own line, have collaborated in the work, and this is as it should be. The science of astronomy has grown to such vast proportions that no one person can be expected to have a comprehensive grasp of the whole field. The present authors have done their work well, and the book is an outstanding testimony to their abilities.

The first volume is devoted to the solar system, but commences with matters of fundamental interest. There is a good introduction dealing with the aims and methods of astronomy, its various departments, the relation of astronomy to the other sciences, its value in practical affairs and as a means of culture. A list is given of the principal astronomical journals and publications of observatories which the student will find of great help to him in his studies. Chapter I is concerned with the celestial sphere and definitions of technical terms used in fundamental astronomy. A useful section on the celestial globe and its use in solving astronomical problems is added. Chapter II deals with astronomical instruments of all kinds, and the fine photographs included will enable the reader to obtain a good idea of their construction. Figure 20 is particularly impressive, showing an observer at the great 100-inch reflector at Mount Wilson, the colossal size of the instrument being well brought out. Chapter III deals with practical astronomy, including navigation. Then follow a series of chapters on the earth, sun, moon, planets, etc., which are both scholarly and lucid, a combination not always achieved

by scientific writers. Personally we should like to see more drawings of the planets as illustrations in the book, rather than photographs. Wonderful as are the results of modern astronomical photography, every practical observer knows that in planetary observation, photography is far behind visual work at the telescope. Drawings of the planets by the best observers reveal infinitely more detail than the best photographs ever secured. By this we do not mean that the illustrations are of a poor order, on the contrary, they are very fine. The diagrams also, are extremely clear and elegant.

Volume II deals with " Astrophysics and Stellar Astronomy," commencing with a chapter on " The Analysis of Light," a term which might well serve as a definition of astrophysics. Then follows a wonderfully interesting chapter on the solar spectrum, in which are discussed such matters as the " Evershed effect," the " Einstein shift " of spectrum lines, the " Zeeman effect " in sunspot spectra, and other matters of up-to-date interest. The chapter concludes with a short exposition of Hale's " vortex " theory of sunspots. Then follow chapters on the sun's light and heat, and on the atomic theory in its relation to astrophysics. After which are successively dealt with, the stars, their movements, luminosities, temperatures, diameters, etc., etc. Other chapters are devoted to " Star Clusters and the Milky Way," " Nebulae," " The Constitution of the Stars," and " The Evolution of the Stars."

The mathematics employed are not of a high order, and should not tax the reader unduly. All matters involving the calculus and advanced mathematics have been omitted. A specially valuable feature of the work, from the point of view of the serious student, is the list of questions and references appended to each chapter. The book seems singularly free from errors, though we have noticed one or two slips, possibly the fault of the printer and not of the authors. Altogether this is the best general work on astronomy we have seen for a long time, and the price seems very reasonable. Both authors and publishers are to be heartily congratulated.

J.A.L.

A New Electronic Theory of Life. By O. OVERBECK. (Published at Chantry House, Grimsby. 6*s*.).

That living activity can be expressed in terms of electricity is familiar to those who have followed recent developments in physiology and physics. The author suggests that as ultimately the constituent particles can themselves be resolved into electric units, the irregularities that arise in the human body are the result of dislocation in this electrically-balanced system. They should therefore be capable of correction by the artificial application of electricity, which it is the purpose of this book to advocate. The efficacy of electric rays in another connexion is illustrated by a reference to the fact that ultra-violet light acting on certain bodies can synthesise vitamines from them, and mention is also made of the quasi-electrical functions of the " hormones."

At the outset of the book a quotation is given from " Atoms and Rays," in which Sir Oliver Lodge states that it is only by treating a subject from many points of view, and by frequent repetition, that it gets any hold on the general mind. " Effective exposition cannot be done crisply and compactly. Room and repetition are needed." This excuses the criticism that the subject under review might have been treated in a shorter space, although it does not justify the frequent over-statements which the author, in his enthusiasm, is led to make. The subject gives rise to interesting considerations, and the book may be summarized by the following passage (page 113): " Superabundance of electricity is associated with happy activity, energy and life, and its insufficiency with sadness, lowness of spirit, and lack of efficiency. These can now . . . be overcome, or at least minimized very greatly. Upon the micro-electric study of ourselves the whole question of our life, health and happiness rests, and it lies with future research to lighten the way."

The British Museum Quarterly. 1927. Vol. II. No. 2. (Published by the Trustees. 2*s*.).

The sixth number of this publication maintains the high standard of its predecessors. The articles include an account of the Ur Excavations Exhibition recently held in the Assyrian Basement section of the museum, when the five thousand-year-old gold dagger and other new treasures were on view. The excellent plates give details of this remarkable find, which was shown in position as discovered with its leather girdle, in the June issue of *Discovery*, while the inlaid gaming board and plaster plaque are also beautifully illustrated. Another interesting contribution deals with an Egyptian leather roll containing hieratic writing, which has never till now been unrolled owing to its brittleness. The details of how this delicate process was carried out successfully afford an interesting insight " behind the scenes " in a museum laboratory.

Books Received.

Man, Spirit, Angel. By THE REV. G. A. SEXTON. (A. H. Stockwell Ltd. 6*s*.).

A Short History of Western Civilization. By A. F. HATTERSLEY. (Cambridge University Press. 6*s*.).

Mind and Life from Atom to Man. By ALBERT DAWSON. (The C.W. Daniel Company. 15*s*.).

Lectures on Theoretical Physics. By H. A. LORENTZ. (Macmillan & Co. Ltd. 21*s*.).

The Antiquity of Man in East Anglia. By J. REID MOIR. (Cambridge University Press. 15*s*.).

Psychology and the Soldier. By F. C. BARTLETT. (Cambridge University Press. 7*s*. 6*d*.).

Annals of Archaeology and Anthropology. Issued by the Institute of Archaeology. Edited by J. P. DROOP and T. E. PEET. Vol. XIV. Nos. 3-4. (Liverpool: The University Press. London: Hodder & Stoughton Ltd.).

That Mind of Yours. By DANIEL B. LEARY, Ph.D. (J. B. Lippincott Company. 6*s*.).

The Opposite Sexes. By DR. ADOLF HEILBORN. Translated y J. E. PRYDE-HUGHES. (Methuen & Co. Ltd. 6*s*.).

Physics in Industry. Vol. V. By H. E. WIMPERIS, O.B.E., M.A., F.R.A.S., and F. E. SMITH, C.B., C.B.E., D.Sc., F.R.S. (Oxford University Press. 2*s*. 6*d*.).

Possible Worlds, and other Essays. By J. B. S. HALDANE. (Chatto & Windus. 7*s*. 6*d*.).

Centenary Addresses. With a preface by DR. R. W. CHAMBERS. (University of London Press Ltd. 12*s*. 6*d*.).

Archimedes, or the Future of Physics. By L. L. WHITE. (Kegan Paul, Trench, Trubner & Co. Ltd. 2*s*. 6*d*.).

The Great Physicist's. By IVOR B. HART, O.B.E., Ph.D., B.Sc. (Methuen & Co. Ltd. 3*s*. 6*d*.).

Collected Papers of Srinivasa Ramanujan. Edited by G. H. HARDY, P. V. SESHU AIYAR, and B. M. WILSON. (Cambridge University Press. 30*s*.).

Annual Report of the Smithsonian Institution, 1926. (U.S. Government Printing Office, Washington. 1927).

Sport and Travel in the Highlands of Tibet. By SIR HENRY HAYDEN and CESAR COSSON. (R. Cobden-Sanderson. 21*s*.).

Making up One's Mind. By W. ROBERTS. (The C.W. Daniel Company. 2*s*.).

DISCOVERY

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Editorial Notes.

To those not actually engaged in research, discoveries appear to follow in such rapid succession that it becomes increasingly difficult to comment on the significance of a particular period. Yet it may well be that in retrospect the most important feature of the past year will be seen to be the vigorous development of scientific method in nearly all branches of industry. To the layman, research in the past has on the whole been synonymous with the efforts of academic workers to extend the frontiers of pure knowledge. One of the most striking and heartening features of modern industry, however, is the application of the scientific spirit and methods to practical and immediate problems. It is not so much a question of new orientation as the apprehension of the distinction between an immediate goal and a more remote one, a question of focus. Research is discovery in the making, and while discovery sometimes appears to be the result of chance it is much more often the result of organized and sustained effort. If chance intervenes, it favours the prepared mind. The realization of the fundamental importance of research —that is, of strict scientific inquiry into practical problems—is made abundantly clear by the character and increasing numbers of the organizations created to pursue it. In addition to the government departments directly concerned with building, chemical, fuel and food research, there are now industrial research associations covering all the important phases of industrial activity in this country. Thus we have associations dealing with cast-iron, non-ferrous metals, cotton, leather, linen, rubber, silk, wool, glass, refractories, flour, confectionery, and the laundry.

* * * * *

The past year saw the launching of a scheme of Imperial research concerned partly with marketing investigations, but more specifically with the problems of agriculture, of animal breeding, with fruit research and problems of storage. It is further significant that during 1927 Imperial Chemical Industries Ltd., representing the largest group in this country of industrial activities based on scientific knowledge, has created a research council consisting in part of distinguished men of science trained in industrial operations, and in part of university professors engaged in academic work but highly sympathetic to practical problems. Lastly, the past year has seen a notable advance in international scientific relations. International congresses were held at Prague, at Berlin, and at Budapest, and these brought together in friendly intercourse workers from all the countries which the events of 1914-1919 had so deeply separated.

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If one single feature of this increased activity had to be selected both for its diffusion and significance it would probably be fuel research. This is partly due to the consciousness of dwindling resources in fuel, both solid and liquid, but perhaps even more to the widespread public feeling that our present methods of using solid fuel are wasteful and insanitary. A superficial survey of the patent journals of this country, of Germany, France, and the United States, shows how active inventors are everywhere in trying to evolve processes and plant for dealing more effectively with fuel. We publish on page 49 a note on the various fields in which coal research is now being pursued.

* * * * *

For his presidential address to the Classical Association last month, Professor Conway chose as his subject "Poetry and Government," with the subsidiary title "A Study of the Power of Virgil." While it was generally known, he said, that the founder of the Roman Empire between the ages of nineteen

and thirty-four— that is, between 44 and 29 B.C.—went through a process of enlightenment which completely altered his conduct, not everyone realized how directly the Emperor was affected by Horace and Virgil. The evidence suggested that these poets, together with Livy, were the source and centre of what was good in the new Empire. Readers of *Discovery* will recall that Professor Conway recently described the political significance in the writings of Livy, and in the address he proceeded to reveal passages of similar significance in the Georgics and Eclogues. Many of those who listened to the address must have envied his pupils the living interest inspired by this unusual approach to classical studies, which are all too often presented as if they were solely a rather musty relic of the past. As Professor Conway said, if we even dimly realize the power that Virgil wielded to revive a faith in goodness in the hearts of his countrymen and their ruler, we cannot think it superfluous to cherish Virgil as a living teacher to-day.

* * * * *

In the great classical writers, in fact, we have a standard of appeal which, though it may not transcend or equal other influences that have moved mankind, is far less subject to question than any other. While fully recognizing that common efforts to discover the secrets of natural knowledge do bring together different nations, Professor Conway said that unfortunately it is also true that the competition for discoveries which may have enormous financial value, or enormous capacity for mischief in war, may sharpen rather than soften the jealousies of nations. And the same dangers of division beset us, in a more insidious shape, when we appeal to men's highest motives. "But," Professor Conway concluded, "the great ideals of the old world, indissolubly linked with the primitive record of Christianity, are preserved for us in letters of gold, in language that escapes all change; they stand behind and beyond our local habits, and our local forms of creed. To them all the peoples of the civilized world look back; and by them the nations of the future may be inspired and brought nearer to each other."

* * * * *

Some days after our January number appeared containing M. Reinach's article in support of Glozel, the international Commission of inquiry published the following statement: "Basing its decision upon the facts that it has determined, and on the exhaustive discussions it has held, the Commission has come to the unanimous conclusion—subject to the reservations made in its report—that, taken as a whole, the exhibits it has had the opportunity of examining at Glozel are not antiquities." The reservations mentioned relate to certain fragments of flint and stone axes, and pottery, which are regarded as genuine, but it is suggested that all signs point to the other objects having been buried quite recently. Perhaps the strongest evidence mentioned concerns various bone implements which the Commission itself unearthed; although found in the same stratum these show different degrees of fossilization, and there are no marks of roots, such as might be expected from the nature of the site. On the other hand, the Commission offers no explanation of how and when the "recent burial" at Glozel was accomplished, and the puzzle has yet to be solved. Our publication of the "defendants'" case was therefore widely commented on as of importance at this juncture.

* * * * *

Two expeditions of unusual interest were described last month to the Linnean Society. In the first place, Mr. C. V. B. Marquand communicated a paper on the botanical collection made by Captain F. Kingdon Ward in the Eastern Himalaya and Tibet in 1924-25. Captain Ward accompanied the last Mount Everest expedition when it started out from Darjeeling, then travelling in an easterly direction from Gyantse to Tsetang over unexplored ground. Next, crossing the Temo La to Tumbatse he entered the region in the neighbourhood of latitude 29° 40′ N., longitude 95° E., where the most important part of the collection was made. A short distance east of Tumbatse a number of high passes over the eastern extremity of the Himalaya were traversed. On the return journey through Bhutan several species were found which had not been collected since they were discovered by Dr. Griffith nearly a century ago.

* * * * *

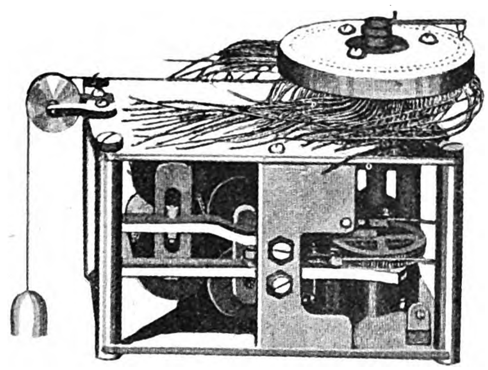
Insect-collecting in the Southern Andes was next described by Mr. F. W. Edwards. The expedition was a joint one arranged by the British Museum and the Bacteriological Institute of Argentina, its object being to make investigations on the mosquitoes and other bloodsucking flies of the Southern Andes, and to form a general collection of insects from the southern beech-forests. Very little work had been done on the insect fauna of this region since the time of Philippi, whose results were published in the middle of last century, and it was believed that much of interest remained to be discovered. Two and a half months, from October, 1926 to January, 1927, were devoted to collecting, most of the time being spent around Lake Nahuel Huapi. From here the party worked their way across to the Chilean coast through extremely interesting and beautiful country. The route taken was the regular one over the Perez Rosales Pass, now increasingly used by tourists.

The Automatic Telephone and How it Works.

The Strowger System.

The development of the automatic telephone, instituted in London at the Holborn exchange a few weeks ago, covers half a century of research. It is hoped to extend the system gradually throughout the Greater London area of more than seven hundred square miles.

FROM the automatic telephone as we know it to-day to the crude product of an inventor forty years ago is a far cry, and the intervening period is rich in records of industry and persistence in research. The Strowger automatic telephone takes its name from Almon Strowger, an undertaker of Kansas City, Missouri, U.S.A., and owes its inception to a suspicion in his mind that a telephone operator was conspiring with one of his competitors to report the Strowger line "busy" whenever prospective customers rang him up, thus diverting his business into alternative channels. The suspicion proved to be unfounded, but it nevertheless inspired Strowger, little as he must necessarily have known of telephony or mechanics, to try his hand at inventing. History records that his raw materials comprised a round collar box, a packet of pins, and a pencil. Details are lacking, but we may postulate that this undertaker-inventor was conversant with the broad principle of manual telephone switching, by means of plugs and cords inserted in metal sockets representing the fixed terminals of subscribers' lines at the telephone exchange, and that he visualized an alternative electro-mechanical rotary switch, in which the pins, stuck round the collar box at regular intervals, constituted subscribers' fixed line terminals, any one of which could be selected at will by a radial contact arm arranged to sweep round the circle.

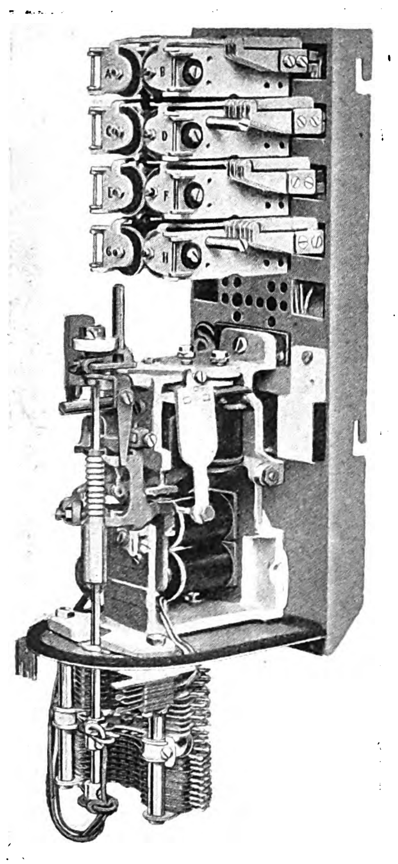


THE FIRST AUTOMATIC SWITCH.
This was used at La Porte, Indiana, U.S.A., in 1892, and consisted essentially of a flat ebonite disc (seen at the top). The rotating arm makes contact with the terminals of the numerous lines.

Strowger, however, made no material progress with his invention until chance brought him in contact with Joseph Harris, then a young commercial traveller, to whom the crude switch was shown merely as a matter of interest and its purpose explained. There, in all probability, the matter would have ended but for an experience which befell Joseph Harris a few days later. Harris knew even less than Strowger about telephones or mechanics, but he possessed imagination, and having occasion to make a telephone call from a small exchange at Carthage, Missouri, he witnessed a flagrant case of inattention on the part of the operator, who was gossiping instead of attending promptly to calls as they came in. The incident recalled his talk with Strowger, and prompted the thought that there were possibilities ahead for the collar-box switch. To confirm his theory he made inquiries as he travelled, improving his knowledge of telephonic matters, but experiencing no enthusiasm regarding the success of Strowger's invention, then considered an impracticable and valueless idea.

All this happened in 1889, but two years later Harris succeeded in floating a company called the Strowger Automatic Telephone Exchange, of which Strowger and he were vice-president and secretary respectively. Manufacturing difficulties followed, and their efforts to interest various existing organizations brought the inventor and promoter into contact with A. E. Keith, a young engineer with whom they joined forces, and to whom belongs much of the credit for putting Strowger's idea into practical shape.

Three years later, in 1892, the installation was commenced of the first public automatic exchange at La Porte, Indiana. The Strowger switches used in those days took the form of a flat ebonite disc, around the circumference of which were arranged contacts corresponding with the terminals of the subscribers' lines. The rotating member or contact arm was mounted on a shaft which passed axially through the centre of the disc, rotary motion being imparted to it by two pawls actuated by electro-magnets.



MODERN STROWGER SWITCH.

The inventor's early idea of a central spindle or rotating shaft is still embodied. The working details are shown in the line diagram below.

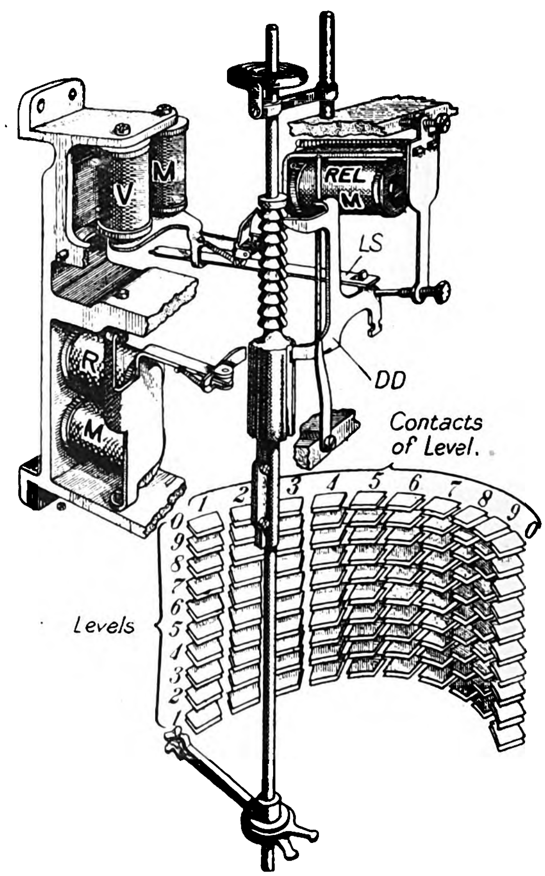
One magnet-pawl combination moved the contact arm over ten contacts at a time; the other stepped it only from one contact to the next. A third electro-magnet released the mechanism by disengaging both pawls, allowing the contact arm to restore to normal, ready for another call.

To actuate this early Strowger switch, no less than five line wires were required from each telephone to the exchange, whilst every subscriber had the sole use of one of these switches, an obviously costly arrangement seeing that many of the switches would be standing idle for the greater part of the day. Moreover, there was no convenient numbered dial in those days for simplifying the calling operation. Each telephone was fitted with keys or push-buttons on which the subscriber, after the manner of a telegraph operator, tapped out the electrical impulses necessary to set up the desired connexion.

In spite of these complications the La Porte exchange worked successfully and gave satisfaction to its subscribers. It was realized, however, that drastic improvements and greater simplification would be necessary to fit the automatic telephone for public service on a large scale. The early principle of individual switches limited the capacity of an exchange, and it was not until the principle of trunking by groups—arranging subscribers terminals in groups and providing facilities for inter-connecting the groups—was introduced, that real progress was made. Meanwhile the Strowger switch had been steadily developed and improved in detail until in 1902 it took a form which, though differing radically from the original, was the prototype of those in general use to-day.

The modern Strowger switch, or "selector," as it is termed, still incorporates the inventor's early idea of a central spindle or rotating shaft, a radial contact arm and contacts arranged circumferentially. To-day, however, the shaft is capable of motion in two planes, vertical and horizontal, whilst the contact arm has access to one hundred sets of contacts per switch. These may be either the terminals of subscribers' lines, or communicate in turn with other groups of Strowger switches, thus indefinitely extending the capacity of the exchange of which they constitute the equipment.

The contacts are arranged in ten rows or "levels" considered vertically, each level comprising ten sets of contacts. Thus grouped they lie, as it were, on the inner face of a semi-cylinder. The rotating shaft is vertical and constitutes the axis of the cylinder, the radial switch arm being rigidly attached to it. Combinations of electro-magnets and pawls move this

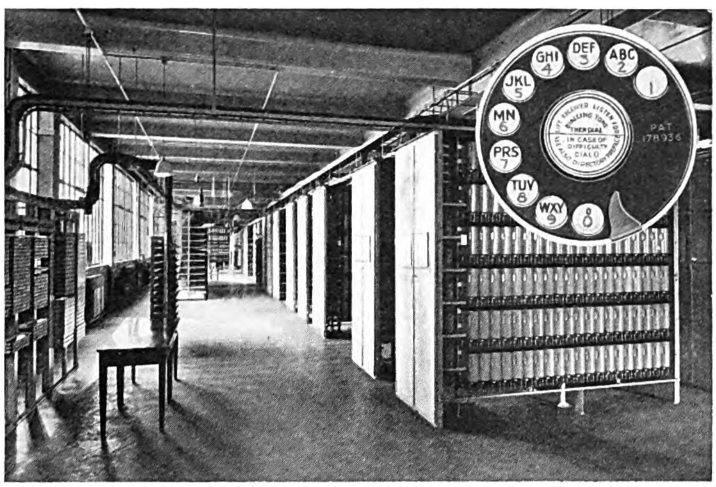


PRINCIPLE OF SWITCH OPERATION.

The shaft is stepped up by the electro-magnet VM, and stepped round by the electro-magnet RM. A third electro-magnet, RELM, effects the release when the subscriber replaces the receiver.

shaft step-by-step, both vertically and horizontally, thus enabling the switch arm or "wiper," as it is called, to sweep over the entire one hundred sets of contacts, selecting and coming to rest on the particular set indicated by the subscriber in dialling the required number.

The vertical movement of the shaft is analogous to that of the monkey-on-a-stick, familiar as a nursery toy, while the subsequent rotary movement resembles that of the hands of a clock, except that less than a half-circle is traversed by the wiper. A spring, assisted by gravity, restores the switch to normal when the subscriber hangs up his receiver, release being effected by a pawl under the control of a third electro-magnet. Such, in effect, is the Strowger switch of to-day, but the subscriber no longer commands one of these ingenious mechanisms for his own exclusive use.



THE HOLBORN AUTOMATIC TELEPHONE EXCHANGE.
This view of the first public service exchange in London shows the many rows of automatic switches. Inset is the standard dial fitted to subscribers' instruments.

Keith, the first engineer associated with Strowger, introduced what has come to be known as the line switch, a much simpler and less costly piece of apparatus on which each subscriber's line terminates. This later development really made the invention commercially practicable, because it immediately reduced the number of switches to those necessary to carry the known traffic, thus approaching nearer to that ideal when the maximum of exchange equipment is in service throughout the periods of busiest traffic. The function of the modern line switch, which now takes a different form to Keith's original model, is to select and retain for the exclusive temporary use of the calling subscriber a disengaged Strowger switch or selector, and it performs this function automatically in response to the lifting of the receiver from its hook.

As regards the subscriber's part in automatic telephony, it was soon realized that the method of selecting numbers by pressing a series of numbered keys or buttons on the telephone was too primitive and involved the user in too complex a method by comparison with the manual exchange system. Gradually the simple and reliable calling dial as we know it to-day was evolved, with its ten finger holes and numbered disc, which considerably facilitated the act of telephoning.

Without going into technicalities, all that the automatic telephone dial does when one releases the disc, after having moved it round with the finger-tip, is momentarily to break or disconnect the line circuit a number of times corresponding with the number dialled. These interruptions in the otherwise steady flow of current over the line give rise to the electrical "impulses" which in turn actuate the Strowger switches at the exchange, causing the shafts to step up and step round until the contact arm of the final switch in a series rests on the terminal contacts corresponding with the required number.

Like all innovations, the automatic telephone was regarded askance by telephone authorities for some years after its invention. Only the smaller independent operating companies in America could be prevailed upon to give it a trial, but slowly and surely its principles were accepted, and wherever it was installed the service improved. When, in 1911, the lease of the then National Telephone Company expired, and the British telephone service reverted to the State, Strowger development had reached a point where its introduction into Great Britain and the colonies appeared opportune.

To facilitate matters and provide a British source of production to meet the stipulation of the British Post Office Telephone Department that all its equipment should be of home manufacture, a British company was formed and in 1912 entered into negotiations with the British Post Office. As a result the Strowger automatic telephones were installed at Epsom, and experimentally at the G.P.O., London. So satisfactory did these initial exchanges prove that they were quickly followed by others at Newport, Accrington, Paisley, Blackburn, Portsmouth, and Leeds. Meanwhile the British sponsors of Strowger automatic telephones had also turned their attention to the Colonies and foreign territories, and as a result equipment was introduced into India, Manchuria, Japan, the Argentine, and other countries.

Up to this period, some six years ago, while not limited to cities of any particular size—the telephone needs, for example, of such metropolitan areas as Buenos Aires and Los Angeles had been successfully catered for—applications of the automatic telephone were restricted by a lack of flexibility. In the largest centres of population, where manual telephone development had already reached considerable proportions, grafting the Strowger system on to the existing network involved wholesale and drastic alterations in exchange names, together with costly modifications in underground cable and wire plant. Had London been devoid of telephone exchanges in the face of its immediate and urgent need for more than half a million telephones, it would have been a straightforward proposition to satisfy this requirement by applying existing Strowger practice.

The New London System.

Under these theoretical conditions the planning of an automatic telephone system for London would have permitted the establishment of an exchange nomenclature and an interconnecting cable and line plant in harmony with known Strowger features. In point of fact, when the proposal to introduce automatic telephones into London was made, more than seventy-five manual telephone exchanges were already in existence in the area ; and these telephone centres with their associated cables and line plant possessed considerable inertia and resistance to the changes involved by the introduction of the automatic system then available. Applying the Strowger principle, in the past it had sufficed to provide means whereby a telephone user could at will select any number connected with his own exchange, or, in a multi-exchange area, could first select the particular exchange in which the wanted subscriber's line terminated, and then automatically connect his telephone with that of the wanted subscriber.

To afford satisfactory telephone service for London on a basis acceptable to the Post Office as the responsible telephone administration, it was necessary for the automatic system to maintain all these facilities without undue interference with existing exchange nomenclature or the junction cables interconnecting the exchanges. Undismayed by this complex problem the Strowger engineers in England and America, some of whom had virtually grown up with the invention which they were sponsoring, set about the task, and, still retaining the switch as a basis, evolved a combination of apparatus known as the " Director " register controller which abundantly justifies Dr. Fleming's eulogy as representing " the high water mark of human creative power."

Operating under the control of a numbered *and lettered* dial attached to the subscriber's telephone the " Director " register controller selects and connects with a telephone wire route from, say Bow to Battersea ; from Mayfair to Whitechapel ; in short, from any district in London to any other district. This accomplished, the Strowger switches on the spot do the rest, by selecting and connecting with the terminals of the particular subscriber in that district. All this occurs at the bidding of a numbered and lettered dial, on which letters representing exchange names have been introduced for the sake of simplicity. Psychology suggests that it is easier for a person to memorize a series of letters and numerals, than a full series of numerals only, especially when he is already conversant with telephone exchange names.

It is, moreover, possible by dialling a combination of three letters, representing the exchange name and four numerals of a given subscriber's number associated with that exchange, to generate, if necessary, a still larger number of impulses required to route the call to the district desired. To describe in detail how this is accomplished by means of the register controller is outside the scope of this article, but it will suffice to mention that this latest adaptation of Strowger principles can receive one series of impulses from the subscriber's dial ; translate it into an entirely different series without mutilation or interference with the numerical portion ; and having passed it on to the particular exchange for which it was destined, immediately disconnect and place itself at the disposal of the next subscriber waiting to call.

The opening of the new automatic exchange at Holborn—the consummation of an undertaker's dream of forty years ago—marks only the inception of a scheme which will ultimately extend throughout the telephonic area of Greater London, embracing no less than 750 square miles and already serving upwards of half a million subscribers.

Cables and Wireless.

THE working relations of cables and wireless are again under discussion, following proposals initiated by certain British submarine cable companies with a view to securing co-operation with the " beam " wireless services. It was announced last month that a joint inquiry was to be undertaken as to a possible arrangement which might be to the advantage of both interests. The matter raises the problem that results from nearly every discovery—how far existing appliances can be related to new developments.

A New Conception of Pope.

By A. G. McL. Pearce Higgins, M.A.

Pope has suffered in the modern tendency to misinterpret the eighteenth century, but is this attitude based on sufficient consideration of the facts? The author suggests that our judgments to-day are bound by rules no less tyrannical than those we imagine to have been self-imposed on Pope and the writers of his period.

POINTS of view are ever shifting, and an aspect all but ignored by one generation will by another be highly emphasized. In common with many other good things of the past, the eighteenth century has of late fallen somewhat into disrepute, and its chief representative, Pope, has shared in the general contempt with which, since Keats, Shelley, and Wordsworth showed the way, it has been the fashion to load that incomparable age. It is the object of this article to suggest that our attitude is based on insufficient consideration of the facts. We have become biased in our judgment from various causes. We have forgotten that "classical" and "romantic" are complementary terms and not opposed. Even if these aspects of poetry were irreconcilable, there is still enough romantic blood in Pope, and abundant evidence that, had he so willed it, he could have used it more generously, to justify us in refusing to allow ourselves to be misled by the prejudices of the writers of the romantic revival. If the truth be told, we are bound in our judgments to-day by rules just as tyrannical as those which we imagine to have been self-imposed on the writers of the eighteenth century. We have but exchanged the slogan "Write correctly" for another, "Write as you please."

Barbarism of Previous Ages.

The poets of the Romantic Revival imagined that they were doing an inestimable service to English literature in freeing it from what they called the fetters of conventional diction, of prosy and dull complaisance in the accepted order of things. They failed to see that they themselves were following in the old direction, though on a new path. Pope believed that he was freeing the language from the barbarism of a previous age; so did Wordsworth, but he quite forgot that had it not been for Pope's previous purgation his own would probably have been quite impossible.

The romantic poets considered the poetry of Pope to be artificial, passionless, and insincere; that "the poetry of the heart" was the only possible kind, and that without perfect freedom in expression and subject matter poetry would be, or rather would continue to be, the lifeless thing it seemed in the hands of Pope and his more successful imitators. Keats in "Sleep and Poetry" exclaims:—

> But ye were dead
> To things ye knew not of—were closely wed
> To musty laws lined out with wretched rule
> And compass vile; so that ye taught a school
> Of dolts to smooth, inlay, and clip, and fit,
> Till like the certain wands of Jacob's wit,
> Their verses tallied. Easy was the task;
> A thousand handicraftsmen wore the mask
> Of poesy. Ill-fated, impious race!
> That blasphemed the bright Lyrist to his face,
> And did not know it—no, they went about
> Holding a poor, decrepit standard out,
> Marked with most flimsy mottoes, and in large
> The name of one Boileau!

This may be fine scorn, but it is far from the truth. The romantic poets failed to realize or appreciate the difficulties against which Pope was contending, and the magnitude of the task he had set himself to perform.

Now Pope, whatever the cause, possessed certain characteristics which there is a tendency to-day to despise. He was a patriotic Englishman who hated hypocrisy and cant, underhand dealings, tyranny, falsehood, and folly; but like most of us he viewed them in a slightly different light if they were likely to be present helps in time of trouble. Hence his apparent lack of morality in dealing with rogues and scoundrels is supposed to be the measure of the man. And yet with the exception of his patriotism—where he would have had more ground and excuse for being unpatriotic than Shelley—the minds of these two poets, in certain spheres, worked on not dissimilar lines. What the one partially achieved by satire the other vainly attempted by tirade. The world was too much with and against Shelley, and he deserted the struggle against things to create a world wherein there should be no human opposition. As he says of himself, though the subject is a skylark:—

> Like a poet hidden
> In the light of thought,
> Singing hymns unbidden,
> Till the world is wrought
> To sympathy with hopes and fears it heeded not.

From the seclusion of the Italian coast he hurled his invective against a land that heard him not, he sang his songs unbidden for ears that listened

elsewhere and to other music, and created Utopias for those who were quite satisfied with the life to which destiny had assigned them. But the other, in the heart of London, a Roman Catholic, a member of a heavily penalized sect, spared not to lash vice with the full fury of his scorn, whether he found it in the crowned head of England or the meanest poetaster of Grub Street. Destructive as his criticism nearly always is, he was slowly and surely, with full knowledge of what he was doing, preparing the way for the idealism of Shelley and the higher moral revelation of Wordsworth. Like all truly great poets he was fully convinced that underlying all poetry there must be a basis of moral purpose. He sometimes made the mistake of believing that mere didactic writing was sufficient, that to aim high was to reach high. But he at least avoided the more serious mistake of letting his pen run into words with no serious thought behind them, in the hope that something of worth might therefrom happen into existence.

Pope and Shelley.

It is interesting to compare Shelley and Pope in their treatment of Liberty. To Shelley Liberty meant a revolt against the accepted order of things. To be free was to "defy power that seems omnipotent," human and divine, to resist to the utmost superimposed authority, and ever to struggle after the ideal of love. Love of what? Perhaps a love of the freedom that should unite the warring nations of earth into one great and peaceful family. But the tragic failure was his inability to realize that love is in itself a most cogent law. He had not learnt the law that service was, and is, perfect freedom; and that very love that he would gladly have died to win eluded him at every turn. But if he never achieved love, he never achieved hate. He howls against the tyranny of kings; they laugh at him. He curses organized religion because it imposes external authority on, and demands obedience from, the human will.

"Oh, that the pale name of priest might shrink and dwindle,
Into the hell from which it first was hurled!"

It was vain. But Pope praised, "damned with faint praise," so softly, so subtly, that the strongest armour is pierced, and George, be he First or Second, is left bewildered and helpless, the laughing-stock of the foolish and the wise. Shelley could not achieve the force and bitterness, and perhaps it was well, of these lines from the "Epistle to Augustus" addressed to George the Second, notoriously indifferent to the arts, it is true.

Oh, could I mount on the Maeonian wing
Your arms, your actions, your repose to sing;
What seas you travers'd and what fields you fought,
Your country's peace, how oft, how dearly bought!
How barb'rous rage subsided at your word,
And nations wondered while they dropped the sword!
How, when you nodded, o'er the land and deep
Peace stole her wings, and wrapt the world in sleep.

In an epic poem the poet is more the historian of than the commentator upon the events he relates; his own personality must remain in the background. But lyric, satire, and all other branches of poetry are dominated by the personality of the writer. To judge from the great poets, the less the writer obtrudes himself, and his peculiarities, the more success he seems to win. And Pope was a firm believer in self-control. Rightly or wrongly he held that many of his inmost thoughts and longings ought to be suppressed, with the result that even in his most passionate moments there is always a pervading atmosphere of restraint, which is probably one of the reasons why to many he seems passionless, or at least coldly unsympathetic. He felt that he was more usefully employed as an "arbiter morum," a judge of the public taste, a mouthpiece of all that was noblest in the life around him, expressing, as he says:—"What oft was thought, but ne'er so well expressed," than a mere recorder of his own personal feelings and emotions. His attitude towards life, though derived, at times blindly, from his friend Lord Bolingbroke, is clearly shown in his "Essay on Man." Again and again in this poem he stresses the need for moderation and caution. "Know thyself," and then try to accommodate that self to the scheme of things. At the same time, in Browning-like language, he offers a splendid hope: "Man never is, but always to be blessed" is strangely similar to "the best is yet to be."

Principles of Good Art.

Let us evolve a principle, Pope seems to imply; *solvitur vivendo*. While the purpose of this poem, the "Essay on Man," like that of the "Essay on Criticism," is avowedly constructive, much of Pope's finest writing is purely destructive. Not wantonly so; but he seems to have felt that he was performing a more useful service to literature in pulling up weeds than in planting flowers, in combatting the diffuse and erratic straining after effects which characterizes the development of poetry during the greater part of the seventeenth century, rather than in perpetrating a similar style himself, or in experimenting in new forms and styles. He perfected the "Heroic couplet"—no mean achievement—and thereafter devoted his genius to what might be called the consolidation of literature. His chief concern was to foster good

art and exterminate "dullness"; questions of "classical" and "romantic"—whatever those words may mean—did not trouble him. Hence his final appeal to reason rather than to imagination. He trusted his head more than his heart. But when imagination appeals to authority either for guidance or approbation, the result is an inevitable crippling of the intellectual faculties. On the other hand, when it came to a question of the English language, of versification and metrical performance, the authorities to whom he could appeal, Waller and Dryden in particular, were too near him in point of time to have achieved the halo of inviolable sanctity that sat uneasily on the poets of Greece and Rome. Reason triumphed in the long run over imagination; that is perhaps why Pope is rarely considered as a romantic poet, but since he is an indisputable link in the chain that stretches from Chaucer to Tennyson and beyond, a label, though misleading, will not affect his reputation. There is in all he writes the true egoism of a romantic poet, chastened and controlled, but differing only in degree from full-blooded romanticism.

Like Wordsworth he refused to be blinded by passion, and though on occasions hate and anger did for a time obscure his vision and pervert his judgment, there is in much of his writing a pathos that brings him closer to Virgil and Tennyson.

Those lines on Addison:—

> Who but must laugh if such a man there be,
> Who would not weep if Atticus were he?

The whole passage, in fact, is not, as some would have it, a masterpiece of satire and hate at all; it is the heart of Alexander Pope fighting against the head. "Who would not weep?" A grain of conscience turned the satire of an earlier version of those lines:—"Who would not *laugh* if Addison were he?" into his nearest approach to the sublimity of:—"Oh, the pity of it."

Gentler Methods.

Other examples of his gentler methods are not far to seek; perhaps his "Epistle to Addison" on the latter's "Dialogue on Medals" will serve for illustration:—

> A small Euphrates through the piece is rolled,
> And little eagles wave their wings in gold.

The quiet unexpectedness of the little wings waved in gold, the attenuated river rolling across a coin—many have tried and all have failed to excel in this style; it is peculiar to Pope. Again, surely it was to these lines, from the same poem, that Gray turned for inspiration for his famous "Elegy":—

> Perhaps by its own ruins saved from flame
> Some buried marble half preserves a name,
> That name the learned with fierce disputes pursue
> And give to Titus old Vespasian's due.

And the following lines from the "Elegy on an Unfortunate Lady," must be held partly responsible for "All that beauty, all that wealth ere gave," etc.:—

> So peaceful rests, without a stone, a name
> What once had titles, beauty, wealth and fame.
> How loved, how honoured, once, avails thee not,
> To whom related, and by whom begot,
> A heap of dust alone remains of thee,
> 'Tis all thou art and all the proud shall be.

A Positive Belief.

The world was not ready then for "Adonais"; nor had it learnt to mourn with gorgeous and passionate insincerity the failure of its hopes. The hopes and aspirations, the vision and morality of the eighteenth century may well have been stifled, its Christianity a mere dogma; but it held fast to a positive belief in what it considered to be right, rather than to a splendid negation of what it did not definitely know to be wrong. The romantic poets solemnly, and often tediously, proclaimed themselves to be emancipators and reformers. But what did they reform, and Whom did they emancipate, and from what? One is tempted to reply that they freed themselves from one code of rules only to impose on themselves and their inheritors another. They discovered that they could not write "Heroic couplets," and very wisely resolved not to make the attempt. They went further; they decreed that it was wrong to write in "Heroic couplets"—the contorted couplets of Keats are meant to be in imitation of those of Chaucer—because so to do involved the use of an out-of-date and conventional vocabulary. Scenes were to be no longer "rural," nor lawns "enameled," nor forests "sylvan"; the "fair one," the "nymph" was to have another name than Belinda or Chloe; she was to be Miranda, or "Jane with a musical instrument," or Isabella with a lover, or Madelene with a fretted screen. Endymion, Laon, and the old Gods of Greece were to restore the Age of Gold, in spite of the assistance of Don Juan! In place of an artificial language we were to have the sweet simplicity of the rustic—not rural—peasant; the peasant who felt so deeply about Westminster Abbey and Milton and Duty. Truly it was fortunate that Wordsworth forgot his own rules. Everywhere prolixity; the necessity for creating the proper "atmosphere" before the story can begin; everywhere

the trivial magnified, the obvious either expanded or ignored.

No other English poet, as poet, till we come to Tennyson, exercised such a great, though indirect, influence on the life of the country as Pope. Pope's standards of morality, such as they were, appealed to and were accepted by the thoughtful men and women of his day, and his often unacknowledged opinions on political and international subjects commanded the respect of statesmen and politicians.

The Conception of Empire.

The conception of Empire was daily approaching a practicable reality, and Pope reacted in the obvious way. Poets, even when they are most revolutionary, are conservative. The Age of Gold is, according to temperament, yesterday or to-morrow. To-morrow, said Shelley; yesterday, said Keats. Pope, with an eye on the past, tacitly decided to accept the present. Given peace and good government, prosperity would follow; and a systematized method of life which set the good and the bad in their places, and made ample provision for the fool and the genius should, he thought, create a world where, if the gout and dizziness of the head could be abolished, felicity should arrive at perfection. And so we have the "Moral Essays," the "Imitations of Horace," and the "Dunciad." Pope seems to have been more successful than Mr. Shaw in ridiculing the vices and follies of his age. The latter rarely makes us angry; he often makes us laugh with and at ourselves. Mr. Pope, on the other hand, lashed his victims into fury, against himself for his unwarrantable impertinence, against themselves for the weaknesses they were loath to see exposed to the public gaze. And so this little hunch-back, who in later life lacked the physical strength even to dress and undress himself, and whose whole soul cried out to be loved and to love again, lived the greater part of his life on the edge of a wasps' nest. But, if the truth be told, he found, where he could not be loved, a grim satisfaction in the danger of being hated. To be provoked gave him excuse for provoking in return, and he knew in his own soul that he could repay the sting of a wasp with the venom of a snake. And yet, at times, indeed, he did feel the stings, and poured his tale of woe into the sympathetic ears of Dr. Arbuthnot; but he never whined about them; he never, like Keats, made sorrow his mistress and the luxury of despair his wife.

Oh let me live my own and die so too!
(To live and die is all I have to do),
Maintain poet's dignity and ease.
And see what friends and read what books I please. . . .
Friendships from youth I sought and seek them still;
Fame, like the wind may breathe where'er it will.
The world I knew but made it not my school,
And in the course of flattery lived no fool.

This is not altogether true to fact, because once or twice, as in the case of the unauthorized (?) publication of his letters, he did descend to folly, if to nothing worse; and his almost childish love of mystification served, by obscuring his purposes, to make men believe the worst, and to ascribe to him motives which a more honest course would have shown to be unexceptionable. Poor Pope! He fell from time to time in the service of his own vanity.

It is an amazing fact that the differences rather than the points of similarity between the English poets should have commanded the attention of the critics; and yet each poet has some characteristics, however small, in common with all other poets. It is natural that they should differ as their individuality differs; they will differ as they attempt to perform different tasks; they will differ as generation differs from generation; but in that they are all English poets they are one. And so, knowing the purpose that Pope had in mind when he first began to write, and from which he never swerved, it is surely wiser to find out how far he achieved his own ideals, than to censure him for failing to achieve a task that he would not or could not perform. That he was a supreme satirist, few would deny. But in his own way, he too is romantic. It is not the romanticism of Keats; not the idealism of Shelley; not the transcendentalism of Coleridge; but, much more to the point, it is what it was meant to be, the poetry of Mr. Alexander Pope.

Disputed History.

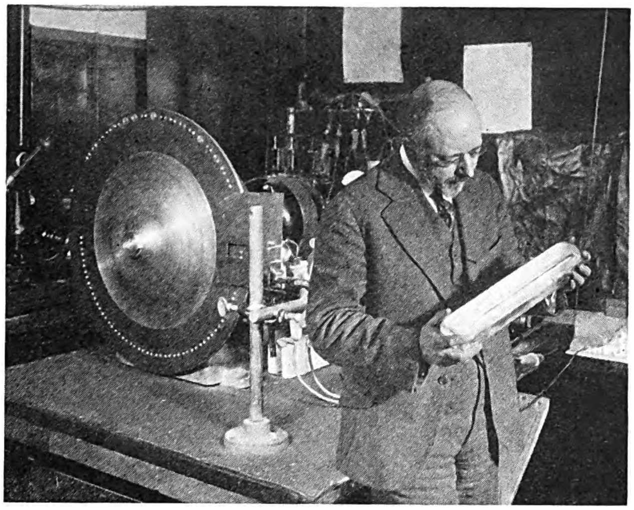
A LEGEND that has gained currency in modern German history books is dispelled by a letter which Sir Rennell Rodd publishes in *The Times* of 18th January. The Empress Frederick (then Crown Princess) was widely held responsible in May, 1887, for summoning the English specialist, Sir Morell Mackenzie, to consult before a serious operation was performed on her husband, whose death shortly afterwards has come to be attributed to his English wife's "distrust of German therapeutics." Sir Rennell Rodd was at the time a Secretary at the Berlin Embassy under Sir Edward Malet, and the papers of his former chief have now come into his hands. Among these he has discovered a letter written in 1887 to Count Bismarck, which states that a similar aspersion on the Crown Princess then published in a German newspaper "is doing her great injury and is devoid of truth."

Television in America.

By William J. Brittain.

The most serious rival of Mr. Baird, the British television inventor, appears to be among the three groups of investigators who are now working on the problem in America.

AMERICA, in her usual enterprising way, is making ready for television. Already a range of wave-lengths has been reserved, and several great wireless companies have announced that they are taking up research on television. Work of importance is being done by three groups; by the American Telephone and Telegraph Company, with Dr. Herbert E. Ives directing the research; by Dr. E. F.W. Alexanderson at the General Electric Company's laboratories at Schenectady; and by Mr. C. Francis Jenkins at Washington.



THE AMERICAN TELEPHONE CO.'S APPARATUS.
This process employs large photo-electric cells, which the director of research, Dr. Ives, is here seen holding. The perforated disc is used in transmission.

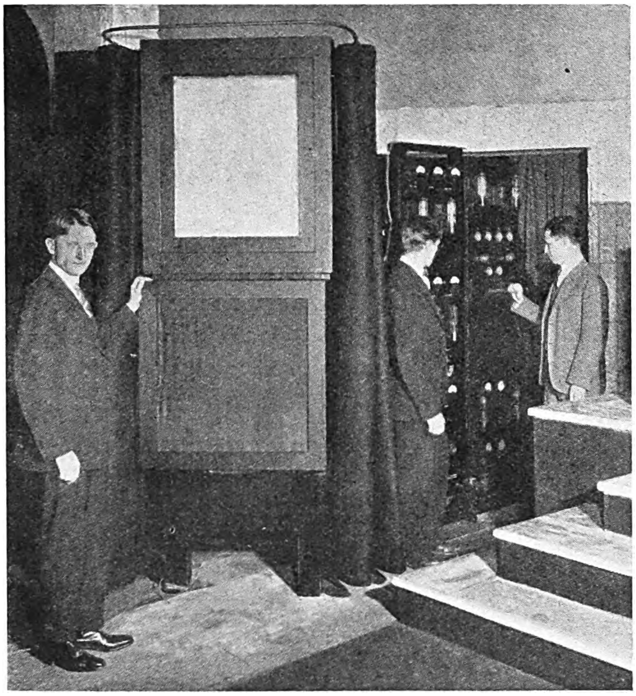
During my television tour of Europe (described in *Discovery* last September), I found that the continental investigators mentioned the United States chiefly when they talked of competition; and Mr. Baird told me recently that he considers the American Telephone and Telegraph Company his keenest rivals, this last-named concern having publicly demonstrated television. On a screen in New York people were able to see Mr. Herbert Hoover, Secretary of Commerce, who was two hundred and fifty miles away in Washington, speaking and turning over his papers; and they saw performers at Whippany, twenty miles away, giving an entertainment.

To scan the object to be transmitted a disc with fifty spirally arranged holes is rotated before a powerful source of light. Thus the object—in this case, the human face—was illuminated rapidly point by point as the light flashed in fifty consecutive beams across its surface. This system enabled light to be used that would be harmful if shown continuously over the whole of the face at the same intensity. Large photo-electric cells were grouped round the object, and as each point of the face was illuminated they sent out an electric signal corresponding in power to the light they received. Amplification by ordinary three-electrode valves intensified the signals to a strength sufficient for transmission.

There were two forms of receiving apparatus, a small one having a rotating disc similar to that at the transmitter, and running exactly in time with it. The disc revolved before a neon tube glowing brightly and dimly according to the currents from the transmitter, and projected on to a screen, two-and-a-half inches square, fifty strips of pink and black to make up the image of the face. The other receiver was far more complex. A long neon tube folded back and forth to make a grid four feet square had 2,500 wires connected to it, forming—with an inside coil—electrodes all along its length. The received current was distributed by a commutator to successive pairs of electrodes, the glowing portions of the tube at the electrodes making up the picture. So clear were the images on both receivers that when a man reading a magazine took his place before the transmitter, the larger pictures in the magazine could be seen on the receiving screens.

According to the company's experts, the apparatus demonstrated is quite suitable for television receivers to be attached to the telephone, so that the person called up can see who is speaking to him; while the large receiver makes it possible for an audience to see a speaker addressing them from a distance. Before outside scenes can be transmitted by television, however, there will have to be great improvements in the fineness of the structure, accuracy, and sensitiveness of the apparatus.

Dr. Alexanderson, at Schenectady, is working chiefly with his television "projector." He has a large



VIEW OF THE RECEIVING STATION.
At the Bell Telephone Laboratories the distant scene is made visible to the audience on the glass screen shown in the centre. Dr. Frank Gray, who is largely responsible for this method of receiving, stands at the left, his hand resting on another screen which contains a loud-speaker.

wheel round the periphery of which are twenty-four mirrors set at different angles. A spot of light directed by an optical system on the stationary wheel is reflected on to a screen in front. As the wheel is slowly revolved the next mirror catches the spot of light and sends it further along the screen. When the wheel is revolved quickly by electric motors coupled with it, the spot of light covers the screen in a zig-zag motion. By having a light fluctuating according to the currents received from a television transmitter, an image can be flashed on the screen. Dr. Alexanderson found, however, that the result with one light was not good. He therefore uses a cluster of seven spots of light, obtaining 49 times as much useful illumination. The screen is now lit seven times as brilliantly and the speed at which the light beam must zig-zag to obtain the same result is reduced to a seventh.

These are the mathematical gymnastics in which Dr. Alexanderson delights. By using a similar method of labour-saving he has made it possible for the high power telegraph stations of the Radio Corporation of America to work with 200 kilowatts instead of 2,000. He believes, indeed, that he is now approaching practical television. "For a reasonably enjoyable moving picture," he states, "there must be 300,000 flashes of light a second. By using seven beams of light instead of one, I need to make each beam of light give only a seventh of that number of impressions—about 43,000 a second. This speed is high, but only ten times the ordinary modulation speed which we use in radio, and therefore within reason." That is to say, by sending his signals over seven waves instead of over one he hopes to solve the problem. His method was demonstrated at a public meeting in New York on 13th January.

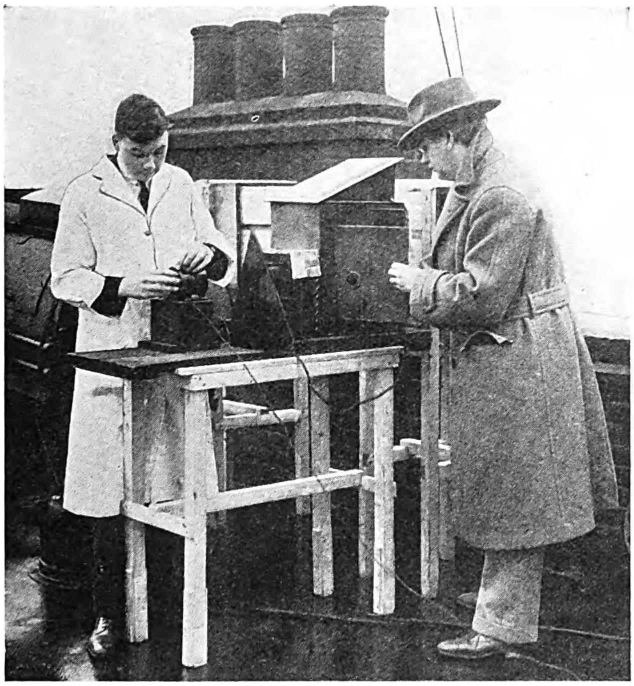
Mr. C. Francis Jenkins uses very effectively a prismatic disc for scanning the image to be tranmitted. The edge of the glass disc is ground as a prism, so that light passing through it when the disc is revolving is refracted back and forth, and can be made to zig-zag over a photo-electric cell or the receiving screen. So far he has produced shadows only, but it is stated that his apparatus needs no addition to its principle to attain light and shade television. If he had not been interrupted in his work by the American Government to develop weather chart apparatus for the navy, he says, he would already have provided television sets for the home. Mr. Jenkins has recently developed a lamp for his receiving apparatus, designed to overcome the great difficulty of finding a lamp that will change its light value rapidly enough with the fluctuations of the current from the transmitter. His new design is gas-filled and has seven individual light sources, which are operated together or in rapid succession by a rotary switch. This lamp may enable Mr. Jenkins to repeat the triumphs of his pioneer work in photo-telegraphy.

Researches in Noctovision.

PLANS have been developed since the new year to further the activities of the British Television Society, which was formed last summer at the Leeds meeting of the British Association. This was the occasion of a public demonstration of noctovision, when Mr. John Baird showed his "noctovisor," the latest development in television apparatus. Noctovision is one of the problems to be studied by the new Society, which exists "to afford a common meeting ground for professional and other workers interested in current research relating to television, noctovision, phonovision, telephotography, and allied subjects." The chairman is Dr. Clarence Tierney, and the executive committee, with Mr. J. Denton as honorary secretary, includes Colonel Yelf and Mr. W. G. W. Mitchell. Meetings are being arranged for London, Glasgow, Dublin, Manchester, Birmingham, Newcastle, Leeds, and Oxford, and a journal for the Society has been finally decided upon. Particulars will shortly be issued of regular meetings which are to be held on

the first Tuesday of the month at The Engineer's Club, Coventry Street, London.

In addition to noctovision, another interesting problem under investigation is phonovision, which opens up the possibility of storing pictorial records of people and events that may be " played " in similar fashion to gramophone records. This development was touched upon by Mr. Baird in a recent article in an American journal, *Popular Radio*, in which he stated that if the output currents of the light-sensitive cell are listened to in a telephone receiver, they are heard as sounds, every object or scene having its own peculiar characteristic sound. For example, the fingers of a hand held in front of the transmitter will give rise to a sound similar to the grating of a very coarse file, while the human face will cause a high - pitched whistle, which will vary in pitch as the head is turned or even when the features are moved.



TESTING THE NOCTOVISOR.
Mr. Baird (right) is here seen testing the new apparatus on the roof of his London laboratories. With its aid vision is possible in complete darkness

" I have had a few phonograph records made," he writes, " of the 'sounds' made by the faces of different persons; by listening carefully to the reproductions of these records it is possible to distinguish between one face and another by the sounds they make! With practice, faces may even be recognized by the sounds produced. A further interesting point is that these records may be turned back into images by making them vary the current at the receiver, so that we can now store a living scene in the form of a phonograph record as well as in the form of a cinematograph film. There is room here for the imaginative to indulge in speculation on the scope for future development along these lines."

Dealing next with noctovision, which he describes as " perhaps the most spectacular development of all in connexion with television," Mr. Baird recalls how in the first demonstrations of television it was necessary to use an intensely brilliant illumination, which caused the sitters considerable discomfort. He was told that even a vaudeville star would shrink from such an intense spot-light. While working on reducing the light necessary, the idea occurred of dispensing with light altogether and using rays outside the visible spectrum.

First of all experiments were made with ultra-violet rays, but these proved troublesome, so the infra-red rays of the other end of the spectrum were tried. By means of these it was ultimately found practicable to dispense altogether with visible light, with the remarkable result that it was possible to see in total darkness. The sitter goes into the transmitting studio and is immediately enveloped in complete darkness. Literally, he cannot see his hand in front of his face, but his friends at the receiving end are able to see him put his hand up in an effort to see it.

" It is unwise to prophesy what may be the full extent of the importance of this development in warfare," Mr. Baird concludes. " It may even render it possible to follow the movements of an enemy when he believes himself to be under cover of darkness. Darkness, the great cloak for military operations, will no longer give so much security.

" It is to be hoped, however, that other uses may be found in peace time for this latest development of television. The fact that infra-red rays possess great fog-penetrating powers opens up possibilities for their use in connexion with commercial navigation.

" These invisible rays are employed in exactly the same way as ordinary visible light. That is to say, the rays are allowed to shine on the sitter, and the 'light' reflected from his face is passed on to the infra-red 'televisor.' As to the distance over which television impulses may be transmitted, any circuit which will transmit clear speech is suitable. That being so, and as we now have direct telephonic communications between London and New York by a combined wire and wireless link, we may, perhaps, look forward with confidence to the day when New Yorkers will be able to see what is going on over 3,000 miles away in the great British metropolis."

Mary Stuart and the Confessions of Paris.

By C. Ainsworth Mitchell, M.A., F.I.C.

A new examination of documents in which a servant named Paris confessed details implicating Mary Stuart in the murder of Darnley, suggests that their admission as evidence was not justifiable. Her "guilt" is rendered definitely uncertain by this fresh light on the problem.

MARY, Queen of Scots, has been judged guilty of complicity in the murder of her husband largely on evidence drawn from the notorious "Casket Letters," supplemented by the depositions of those who had been executed for their share in the murder. As explained in a previous article,* the "Casket Letters" were produced before the English Commission appointed to inquire into the Queen's affairs. These documents purported to afford written proof that, prior to the death of Darnley, Mary had not only been in love with Bothwell but had also signed an agreement to marry him; and further, that she had written letters to him clearly indicating that she loathed her husband and was privy to a plan to murder him.

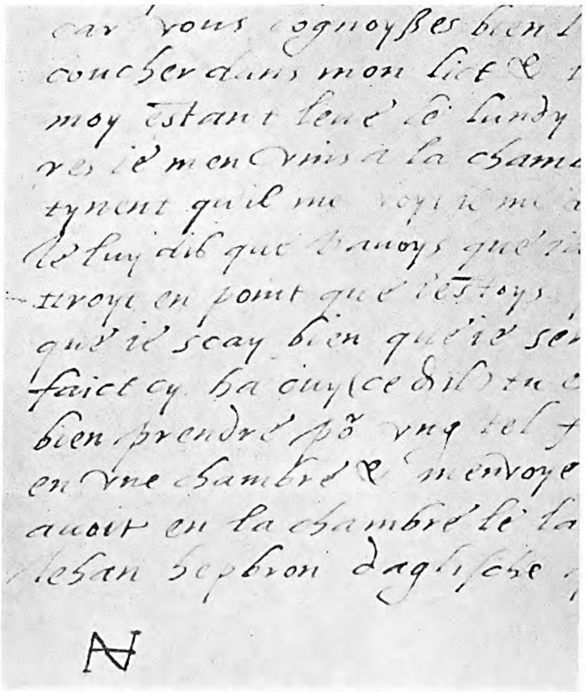


FIG. I.
PART OF THE SUPPRESSED CONFESSION.
The initials "N. H." (N crossed by a stroke) seen in this portion suggest that Hubert was unable to write, but they express his consent to the document.

Among the depositions advanced in support of these letters was one of Nicholas Hubert, more commonly known as French Paris, or simply as Paris. The details given in this confession of the actions of the Queen and Bothwell are so circumstantial that they have convinced many who have hesitated to accept the letters as genuine. If, however, the confession itself cannot be accepted as valid evidence, it must also tend to discredit the letters, since the documentary evidence in any case must form a consistent whole.

Paris, as his name suggests, was a Frenchman who, for some years prior to 1567, had been in Bothwell's service, and shortly before the murder of Darnley had become a confidential upper servant (chamber child) in the household of the Queen. One of his duties was to carry the Queen's private letters to her secretary and others, and his name appears prominently in the "Casket Letters' as one of the messengers whom she is sending to Bothwell. In the so-called "Cecil's Diary of Events," which was produced before the English Commissioners, there are several allusions to Paris, the most significant of which (here rendered into modern spelling) are the following:—

February 5. "She lodged all night under the King in the chamber wherein the powder was laid thereafter, and whereof Paris her chamber-child received the key."

9. "She and Bothwell supped at the banquet with the Bishop of the Isles, and after passed up, accompanied with Argyle, Huntly and Bothwell, to the King's chamber, and there they remained cherishing him, while Bothwell and his (ac)complices had put all things to order, and Paris his chamber-child had received in her chamber the powder, and came up again and gave the sign. And they departed to Bastien's banquet and masque, about eleven hours, and thereafter they both returned to the Abbey, and talked till twelve hours and after."

10. "Betwixt two and three of the clock the King was blown in the air by the powder."

After Mary's defeat at Langside and her flight to England and Bothwell's escape to Scandinavia, French Paris and several of Bothwell's servants who were believed to be implicated in the murder of Darnley were arrested, and having been forced to confess their guilt were executed. On some of their confessions appear to have been based these statements in "Cecil's Diary."

* "The Spurious Marriage Contract of Mary Stuart." C. Ainsworth Mitchell. *Discovery*, Vol. VI, p. 199.

Two separate confessions of Paris are extant, one made on 9th August, 1569, and the other the following day, and it was the later one only that was sent to England to be produced if additional proof of the Queen's guilt was required (Goodall,* II, 88). It is not difficult to discover a reason for the suppression of the first confession, for it tends to implicate Maitland, who came to England as one of the Queen's accusers, as one of the prime instigators of the murder, and its evidence would therefore have been more comprehensive than was wanted. This confession, however, is as worthy of credence as the second one, for both are attested similarly and they must stand or fall together. Both confessions were made in French, and the original of the suppressed document is still to be seen in the British Museum.

Like its companion, it was drawn up at St. Andrews. It bears no signature, but is initialled on four of its pages with the letter N crossed by a stroke (*i.e.*, N. H.), and from this it may be inferred that Paris was unable to write (see Fig. 1). The confessions were read over to him, however, and he signified his assent to what was read. This document was first published in the eighteenth century by Calderwood in the form of a translation which was reprinted by Goodall (I, 137). It opens with a conversation between Bothwell and Paris in a nook between two doors in the Queen's chamber at Kirk o' Field, and tells how Bothwell said that "among us we have decided to blow him (*i.e.*, Darnley) up with powder in the house." Paris remonstrates and says that it will bring trouble on them all, but Bothwell silences him with the remark

FIG. 2.
CONTEMPORARY SKETCH OF THE MURDER OF DARNLEY.
This illustrates the theory commonly held at the time that Darnley's house was "completely wrecked" by a mine, which could hardly have been caused by the explosion of a "heap of powder" mentioned in Paris's confession.

that he has the support of Argyle, Huntley, Morton, Ruthven and Lindsay, and especially of Maitland of Lethington, "one of the best ingines or spirits of his country, who is the enterpriser of all this thing." Paris then proceeds to eulogise Murray,† and asks how he will receive it, to which Bothwell replies that Murray will neither hinder nor help in the matter.

In the second part of the confession Paris describes how on the following Sunday, against his will, he had admitted to the Queen's chamber John Hay and John Hepburn, who had brought the powder and laid it down in the midst of the chamber, how the Queen had gone to the wedding festivity of her servant Sebastian, while Bothwell, Hay, Hepburn and Paris himself waited in a nook in the King's garden when "a great thunder

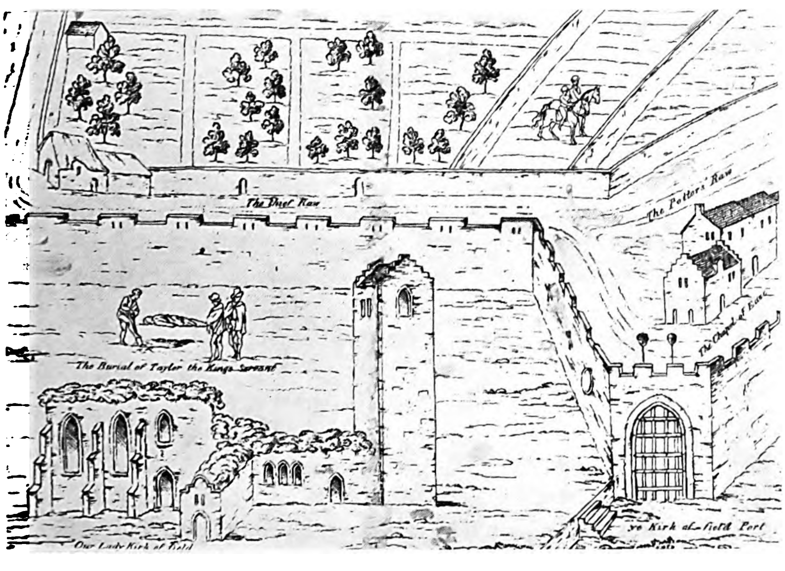


FIG. 3.
ANOTHER PART OF THE CONTEMPORARY VIEW OF KIRK O' FIELD.
In this sketch the positions of the buildings have apparently been reversed as in a negative.

* See Bibliography at conclusion.

† The Earl of Murray (Moray), the Queen's half-brother, who, as Regent of Scotland, was the chief Scottish Commissioner at the Westminster Conference. (*cf. Discovery*, Vol. VI, p. 200.)

clap like a tempest rose up." All fled away to Bothwell's chamber in the Abbey, where Bothwell told them that the crime lay not to their charge but to the Lords of the country, who with him had committed it.

The Second Document.

According to Anderson the original of the second confession is in the Record Office, and a contemporary copy, endorsed by Cecil, is in the British Museum. This document is in narrative form, interspersed with interrogations and replies, and the evidence it provides is very telling. It describes how Paris had travelled with the Queen to Glasgow, after leaving Bothwell at Callander, and how after two days in Glasgow he had been sent with letters to Maitland (the Queen's secretary) and Bothwell in Edinburgh, and had returned to Glasgow on the afternoon of the next day, and delivered the replies to the Queen. From the point of view of confirmatory evidence of the letters these are the most important passages of the confession, the later portion of which gives particulars of the murder of Darnley, but omits the compromising reference to Maitland of Lethington, Morton, and the other lords.

Before considering the bearing of this confession on the subject matter of the letters, it is necessary to deal with a discrepancy between the first and second letters themselves. The Scottish nobles assert in their diary of events (Anderson, II, 269), that Mary arrived in Glasgow on Thursday, 23rd January, and that on Monday, 27th January, she left Glasgow and brought Darnley to Callander on the return journey to Edinburgh.

If the internal evidence of the first letter is to be accepted, it was thus begun on Friday, 24th January, and was not finished until late on Saturday, and hence could not have been sent off by Paris until Sunday morning, 26th January. But the second letter which, according to its own statement, was not sent off until Saturday morning, 25th January, expresses the writer's disappointment that Paris (who did not leave Glasgow with the first letter until the following day) had not yet returned with an answer to the letter which had not yet been sent.

It has recently been asserted (*History*, 1927, XII, 45, p. 42), that "the bottom has been knocked out of this argument" by modern controversialists. The explanation put forward (*e.g.*, by Henderson and by Lang) to explain away this fatal time discrepancy is that the chronological order of Letters I and II was reversed, either by accident or with the idea of first showing the Queen's disposition towards her husband before putting forward the most damning letter of the series.

But even if Letters I and II were reversed, there still remains the evidence of the Scottish lords in "Cecil's Diary" and the evidence of the confession of Paris to be squared before the times will fit. Both Lang and Henderson are precise on this point. Lang says :—"If the Lords are right in declaring in 'Cecil's Journal' that Mary left Edinburgh on 21st January, 1567, and arrived in Glasgow on 23rd January, then the evidence of the letter is incompatible with that of Paris, and one or both testimonies must go."

Henderson ("The Casket Letters," p. 88) is equally aware of the fatal character of the discrepancy, for he says :—"Certain statements of French Paris would indicate that the letter was dispatched on the 24th, but it has been objected that his confession was obtained in a suspicious manner, and is insufficiently attested. In any case his statements cannot be accepted as unimpeachable, and therefore may be left out of consideration, especially as his confession was made subsequent to the Westminster Conference."

Conflicting Evidence.

The audacity of the conclusion is amusing. A certain document is put forward by the Scottish lords as confirming part of their evidence against the Queen, but only to be produced if essential to their credit; it contains statements which cannot be reconciled with those of other integral parts of the documentary evidence, even after they have been transposed to reconcile their own difficulties, and therefore may be "left out of consideration." Historians will be glad to know of this easy way of "knocking the bottom out of an argument." There are also some curious discrepancies between the accounts of the murder as given by Paris and in other contemporary statements. According to this confession, the powder was merely laid on the floor of the Queen's chamber, which is difficult to reconcile with the statement that Darnley's house was blown up "with such force and vehemence that of the whole lodging, walls and others, there was nothing left unruined and reduced to dross to the very ground stone."

It was commonly believed at the time, and this is borne out by the contemporary sketch (Fig. 2), that the house was completely wrecked by a mine laid in the foundation, as Buchanan asserts in his "Actio," which would hardly have been the result of the explosion of a heap of powder laid on the floor of a room. Again, if the statement of Paris is correct (and Buchanan tells the same story in his "Detection"), Darnley was killed by the explosion, but if we are to accept

another statement by Buchanan (*History*, p. 215), the murderers, in three gangs, one of which was headed by Bothwell, silently stole into the house, opening the door with false keys, strangled Darnley and his servant Taylor, and carried their bodies into an adjacent garden (*c.f.*, Fig. 3), after which the house was blown up "from the very foundations." The strangling story was commonly accepted at the time, and is cited by Sir James Melville (Memoirs, p. 86,) who says that "Bothwell . . . had before laid a train of powder under the house where the King did lodge, and in the night did blow up the said house with the powder; but it was spoken that the King was taken forth and brought down to a stable where a napkin was stopped in his mouth, and he therewith suffocated."

Motives of Prudence.

It is impossible now to determine which of the contradictory versions given by Buchanan is true, or to decide whether more weight should be attached to the confessions attributed to Paris, than to the conflicting statements of one of the principal accusers of the Queen before the English Commissioners. It was probably from motives of prudence that the first confession of Paris was suppressed, and for the sake of consistency in their documentary evidence Mary's accusers would have done well to suppress the second one, too.

My examination of these remarkable documents strengthens the conclusion to which I came from an examination of the "Casket Letters," namely, that they show irreconcilable discrepancies and that their admission as evidence was therefore not justifiable. Fairness to an accused person has always been an axiom of English justice, but to condemn Mary, Queen of Scots, on the evidence of contradictory documents, which she was not allowed to see, was the negation of fairness. The canons of what is fair in human dealings do not change with the lapse of time, and a course of action which would not for a moment be tolerated in the twentieth century cannot be justified now because it happened to take place in the sixteenth century.

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Fuel Research Notes.

Investigations on coal are at present proceeding along three main lines. The first is the treatment of coal with hydrogen under high pressure, to produce motor spirit and fuel oil. This method gives a higher yield of oil than any other method so far applied to coal, but it is costly in the initial plant and requires cheap hydrogen, and it cannot be stated to be commercially established as yet. The second method is the conversion of coal into gases, some of which are then caused to interact for the production of liquid fuels. The third method—to which special attention has been given for a long time in this country—is the low temperature carbonization of coal, that is, the treatment of coal by heat away from the air at temperatures varying from 400 to 600° C. below the temperatures at which gas works operate in the manufacture of coal gas. Over two hundred processes to deal with coal in this manner have been described. One can only wonder at the fertility of invention manifested, based on and inspired by the belief that the problem is solvable and worth solving.

The Fuel Research Board and a number of public and private organizations are actively engaged in testing out a number of these processes on the industrial scale. The result aimed at in varying degrees by all these processes is the production of a readily ignitible fuel which will burn without smoke; of a liquid product known as primary tar, quite different physically and chemically from ordinary tar, and of a rich gas of high calorific value capable of special uses. The smokeless fuel, apart from its obvious domestic use, is finding new outlets because of its homogeneous nature and the ease with which, as a result, its combustion may be regulated. Chief among these is the direct feeding of the hot and reactive fuel on to the chain grates of tube boilers leading to a considerably increased efficiency. The use of this fuel, whether in pieces or pulverized, is already proving of the greatest interest to electricity generating stations. Our knowledge of primary tar is not great, but is growing, and this material may well prove to be a rich source of new raw materials. We observe, for example, that it is claimed to contain isoprene, which is one of the more promising starting points for the manufacture of synthetic rubber. Apart from this it can be made to yield motor spirit and valuable fuel and lubricating oils. In conclusion, it may be said that the commercial realization of this method of treating coal has been brought appreciably nearer by recent research.

The World in the Home.

By Edward Liveing, M.A.

Manchester Station Director, British Broadcasting Corporation.

Appropriately the author has left for the last article in this series a subject which presents perhaps the most important aspect of broadcasting. The international possibilities of this new medium are unbounded.

"When the house is built, Death enters in"—so run the words of an old Spanish proverb. In the series of articles which is concluded* in this number of *Discovery*, I have endeavoured to weigh the significance of broadcasting as a force permeating our social life. I have set about my task with a very definite object in mind. Broadcasting is an institution that has been built rapidly, and there are still sceptics among us who regard it as a house built upon sand and not upon rock. Its novelty, its pristine wonderment as an invention are wearing off, they would say, and it is already a moribund achievement. Yet another school of critics has always maintained the intellectually superficial point of view that broadcasting should be employed solely for amusement and entertainment.

A Mental Stimulant.

Why is it, then, that not only are new listeners recruited in all parts of the world day by day, but also that nearly all those listeners, who have installed and used reception apparatus for several years past, are continuing to use it ? I think the reason is this. When the listener's initial and rather feverish excitement, which leads him to turn on his wireless set every night of the week, dies away, he begins to use his discrimination with regard to programmes, and he finds himself selecting beforehand those particular items—symphony concerts, speeches, news bulletins, special talks, whatever they may be, that especially attract his interests. He is, in other words, no longer employing broadcasting as a drug to his senses, but as an active stimulant to his mind. This is the process experienced by the majority of intelligent individuals, and it is this which is destined to make of broadcasting a social force of the first magnitude. As with the individual in marriage, to which our Spanish proverb refers, so with a new invention. The early brightness of achievement dies away as the invention becomes an institution, and is fused into the common stock of our civilization. But its power, less superficially displayed, becomes, in its very fusion with the things of life, deeper and more vigorous, lending help to the old and impulse to the new.

* Next month the author hopes to reply to the criticisms which have been published from several correspondents.

It is broadcasting as a factor in internationalism that we may well review in this last article. The advance of scientific knowledge leads us to-day to apply the word "change" rather than "progressive evolution" to the fluctuations of human civilization, but it may safely be suggested for general purposes that the welter and chaos of the era through which we are passing may be described as the adolescence of the race taking place after thousands of years, and maturing at a speed which entails acute conflict and struggle between the different members of the body. This surely is not disintegration, but the inevitable conflict experienced in general union. Behind all the apparent strife a vast glandular system of new ideas and impulses is working. In every stage of civilization new means of expression play their part in the consolidation of such impulses. The ether knows no boundaries, and I think that future historians, in recording the story of this century, will agree that broadcasting was the most potent agent in the cause of international peace through its propagation of international culture and languages.

New Developments.

To-day listeners may turn on their sets and listen perhaps to a talk on the French language which is being heard by their fellow-listeners in Germany, or to an American revue in a London studio. Listening to European stations has become quite a commonplace affair to users of powerful valve-sets, and a growing number of enthusiasts reach out for programmes from the United States and Canada.

The use of powerful valve-sets is, however, denied to the majority of listeners, and it is into the homes of the majority that the broadcaster has the task of introducing the world. Fortunately ways and means are not wanting and are being rapidly developed and utilized. The telephone cable system of European countries is being greatly improved and modernized, and will eventually be suitable for the establishment of a European simultaneous broadcast system, such as those arranged already in Great Britain, Germany,

and Spain, by means of which the stations in the large cities are linked up with one another and can exchange programmes. A notable instance of the use of "wired wireless" was the relay to British stations of the opening ceremony of the Menin Gate Memorial last summer, the ceremony being relayed by land-line through Brussels direct to London.

Imperial Broadcasting.

With the development of broadcast reception, however, and the establishment of high-power stations we have the alternative to "wired wireless" of programmes radiated from a station of one nationality, picked up on powerful receiving sets by other nationalities, and rebroadcast through the stations of those nationalities. Thus a Glasgow station of the future might transmit a Scottish programme to Europe one night and receive the next, in common with other stations, a Castilian programme from Madrid. The B.B.C. has a special receiving station at Keston in Kent, which is being increasingly used for picking up programmes from the Continent, the United States, and the Empire, and relaying them through its chain of stations, while it has instituted a new short-wave station in 1927 for Imperial broadcasting. Nearly all the outstanding international ceremonies are now available to users of simple sets in many countries—speeches from the League of Nations assemblies at Geneva, the speech by the Prince of Wales at the opening of the Peace Bridge between Canada and the United States, and the retransmission in the United States and the British Empire of a portion of the 1927 Armistice Day programmes transmitted from London, being a few instances readily called to mind.

Ways and means are not wanting; they are being developed and will gradually be perfected. But many problems, quite apart from the technical ones, in this broadcasting exchange confront us. First and foremost is that of the language barrier. It may be said truly enough that broadcasting is already doing much to remove the barrier by language talks. Future generations, learning two or more languages in better ways and with more extensive facilities than existed in our youth, will have no difficulties with foreign programmes, two or three languages perhaps being used as the standard international broadcasting media for programme announcements. Meanwhile an interesting evolution is taking place in the languages of most nations in that the voices of wireless announcers are creating and maintaining a new cultural standard for the spoken word. This development certainly should make an international exchange of programmes easier to the listener, no matter whether the programme emanates from Rome or from London.

The announcing of programme items in two or more languages is admittedly a cumbersome method; in any event the method is inapplicable to plays, opera, and the majority of talks. The rival claims of English, French, Spanish and German as international languages have been put forward in so many different books and articles that I do not propose with my inadequate knowledge to add to the controversies that have been created. It is conceivable that Esperanto or some other artificial language may be largely used. Lessons in Esperanto are already broadcast by stations belonging to the German organization. It is even conceivable that in the course of many years an international language will be evolved with the support of a central broadcasting board set up to deal with the linguistic problem.

Meanwhile, much valuable and unostentatious work is being done, through the various national broadcasting organizations, for the consolidation of international friendship and sympathies. Foreign novelists, foreign singers, modern foreign composers and conductors, frequently appear before the microphones of stations in this country. Most stations to-day transmit talks on foreign travel.

A Poet's Prophesy.

In taking hold of the air as we have done, we have brought the home into the world and the world into the home. Shelley likened life to "a dome of many-coloured glass." To this dome broadcasting holds its mirror, but has not yet reflected more than a few of its facets. It has come into our midst to play a great part in the expression of national and international culture. Broadcasting knows no such things as frontiers or boundaries. There is a prophetic note in some lines from a British poet's ode on "The Spirit of the Spheres," written long before broadcasting was even imagined as a possibility, but which may well be quoted at the end of our survey of this new social force :—

. . Thou art light and thou art free,
And to live rejoiceth thee,
Where the splendours greatest be. . .

Thou a seraph art to go
All undaunted to and fro
Where the finest ardours glow. . .

Thou an angel art, and well
It sufficeth thee to dwell
In the smallest creature's cell. . .

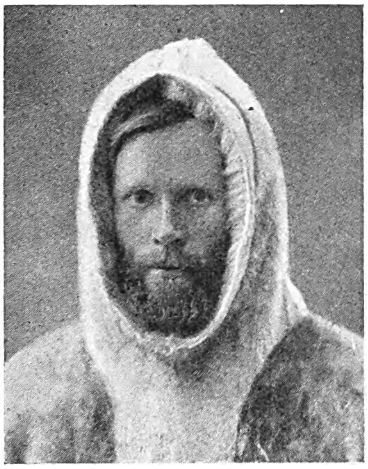
Thou a spirit art most sweet,
And to make all life complete
Everywhere thou hast thy seat.

Winter on an Arctic Island.

By Christian Leden.

The following are some typical pages from the diary of the author, a Norwegian explorer who has lately spent several years among the Eskimos in Arctic America. The photographs are of scenes selected from a cinema film which he has prepared, while a book on his experiences has been published on the continent.

THE October storms are raging and breaking up the ice as quickly as it freezes. As long as this weather continues I am kept a prisoner on a desolate island north of the Hudson Bay. Besides myself the island has four other inhabitants—three Arctic rabbits and "Nannok," a half-grown dog who keeps me company. I call him "Nannok" because his head is like that of a polar bear, and the Eskimos call the polar bear Nannok. On a small island nearby live a couple of Eskimo families who, like myself, are waiting for the ice to freeze, so that they can cross to the mainland with their sleighs. They want to go west, hunting wild reindeer, and I will go south to visit the "*Karnermiut*" and other island tribes. Officially my Eskimo neighbours live from seal hunting, but actually they are now living upon old rotten walrus flesh, originally intended for dog food. Until the ice is frozen it is hopeless to look for seals.



THE AUTHOR IN ESKIMO COSTUME.

My own rations are very low indeed. I have about twenty pounds of rolled oats, a little tea and sugar, a few hard biscuits bought long ago from a fur-trading station in the south, a small case of dried vegetables—and fifty cartridges for rifle ammunition. This is all that is left of the provisions rescued two years ago from a shipwreck. Everything else that was saved then is now about 150 kilometres south from here, on the south coast of Chesterfield Inlet. Because I have so little food I have decided that it is wisest to live alone. At ebb tide the island on which the Eskimos live becomes a sort of peninsula attached to my island, so they can visit me by springing from rock to rock. Thus I regularly have daily visits from them. If the Eskimos crowded into my tent at every meal time I would not have the heart to refrain from sharing with them, and then none of us would have enough. I have therefore accustomed myself to cook and eat only at flood tide. Perhaps this may seem cruel and selfish, but with the Eskimos as table guests my provender would vanish in two or three days, whereas it will last me for six or eight weeks when I take my meals alone—until the sea is frozen and I can make my way down to Chesterfield.

This long tedious period of waiting for the ice to become solid I utilize to develop the films which I have taken during the last two years. I have to do this at night, for my snow house cannot be darkened during the day sufficiently for my purpose. I begin this work immediately after my evening meal and work ordinarily until about six in the morning. Then I sleep awhile until the next flood tide, when I prepare my breakfast and lunch. For practical reasons I find it best to combine these meals. Sometimes I sleep too long, and thus save both breakfast and lunch. Then I prepare my supper and begin again with the

ESKIMO WOMAN (RIGHT) AND HER SON.

During the unsettled period, before the ice was frozen solid, the author's Eskimo neighbours were unable to hunt seals and lived on walrus flesh.

THE DOG "NANNOK."

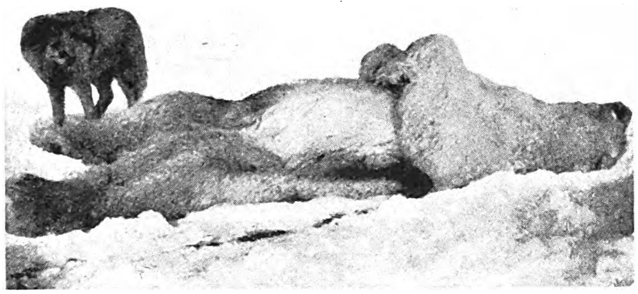
films. Now and then while I am sleeping my lamp goes on strike. Then the hut becomes so cold that the films freeze dry, which is not the best way of drying films. However, I managed to save about 2,000 feet of film. When this work is done I have nothing to do but listen to the melancholy music of the storm and to be on guard against the polar bears. Through the developing of my films I have become accustomed to waking all night and cannot sleep. Often my thoughts wander to my friends and relatives in the civilized world, with whom I have had no communication for a long, long time. I see them before me again, and remember the happy hours we spent together.

* * *

At last the ice begins to freeze and the polar bears are less troublesome. They have enough to do, sitting by the seals' airing holes in the ice and waiting for *Pusi*, the seal, to come there to breathe. Some time ago when I returned from a hunting trip, I found my snow house completely ruined. The Eskimos on the neighbouring island told me that they had seen three white fellows paying me a visit. Apparently they were so annoyed at not finding me

THE OCTOBER STORMS.

ESKIMO SNOW HOUSE.
The author was marooned and while waiting for the winter's freeze to set in lived in a snow house. The stick seen against the wall is about six feet in length.



A GIANT POLAR BEAR.
The size can be judged by comparing the carcass with the dog standing over it.

at home that they smashed my house. As all the men from the Eskimo camp were absent hunting there was no one to take vengeance on the rascals. Women do not as a rule fight with such as my visitors, who were polar bears.

* * *

Although it is now November, the ice is still so thin and unsafe that it is difficult for us to hunt seals. The bears, however, are busy. They have no dread of breaking through the ice. Recently we saw two of them at work and followed them, but they kept nicely out of range of our guns. They preferred such thin ice that we could not get near to them. The ice on the sea will carry a bear when it would not carry a man. In walking a bear distributes his weight on four great flat feet, scarcely lifting them, but sliding along somewhat like a human being on skis; whereas a man puts all his weight on one leg at a time (for an instant). It is useless to compete with bears in hunting seals, and as the bears themselves also are too clever to let themselves be caught, we shall soon have little or nothing to eat.

This hard climate makes it essential that a human being has some flesh for meat and also some fat. It is impossible to live on oatmeal and biscuits when winter begins in earnest. But I cannot bring myself to the point of eating the foul-smelling walrus flesh intended for dog-food, and, however I may regret it, I must see if I cannot manage to bring the rabbit triplets to my cooking-pot. I have decided that

these rabbits are brothers, and that they must have been born on this island. At intervals of a few days I use a cartridge for each of the three rabbits. I cook them whole and gnaw at their poor thin bones as long as anything remains thereon, then my friend "Nannok" gets them to exercise his chewing muscles and his puppy teeth. Thus the rabbits also are released from their dreary existence on this island.

My dog friend and comrade has as yet experienced no hunger. He has no objections to the ancient and odorous walrus flesh and eats his belly full daily. I have learned to love this beautiful intelligent animal, and it will be difficult to part with him when I go south, at the end of November. "Nannok" is still too young to be used as a sleigh dog, and I must leave him for the present with an Eskimo friend. I have promised the Eskimo that he shall have the dog when I go to "*Kabluna Nonnani*" (the land of the white people), but upon the condition that "Nannok" shall be particularly well cared for and kindly treated. Poor "Nannok"! He makes a terrible fuss when I leave. He has to be tied to prevent him from following me. I hear his plaintive howls far out on the field ice and I am on the point of returning. But I pull myself together and go on. The longer I keep the true-hearted beast, the harder will it be to part with it—and I cannot take him back with me to the civilized world. . . .

The Marsh Warbler's Mimicry.

By E. W. Hendy.

Whether the mimicry of the marsh warbler is conscious or instinctive is a problem that has yet to be solved, but the " sweet, silvery individuality " of its song makes it an unmistakable bird for observation.

To many who love birds the marsh warbler is something of a mystery, for it is sparsely distributed, and it is only in comparatively recent times that it has been recognized as a British-breeding species. Whether this is due to its having been overlooked, through its close resemblance to the reed-warbler, or to its having extended its breeding range, is a matter upon which there is some difference of opinion. And as its principal haunts are in the southern counties it is little known to naturalists who live in the North of England. It has only once been known to breed in Cheshire.

There is a tract of flat, low-lying country which, within historical times, was an impenetrable marsh formed partly by the undrained overflow of sluggish rivers, and partly by the salt influx of the sea. Even to-day the land is only a few feet above sea-level, and the flora is partly maritime. In a wet winter it is still inundated, though no longer by salt water, for weeks and even months together. The bones of pelican, cormorant, puffin, whooper swan, sea eagle, kite and crane, dug up by industrious antiquarians from its peat beds, give some indication of the profusion of its bird life in the past. The bittern, indeed, still occurs, but meets its usual fate at the hands of the ignorant gunner or selfish collector. To-day, it is a vast expanse, half wild, half tame, of rough meadow, pasture and osier beds, sweeping to a line of hills which rise scarcely to a couple of hundred feet.

It is the osier beds that the marsh warbler loves, and of these he usually chooses the taller ones, growing to a height of eight to ten feet. There are no hedges, but in their place are broad ditches, or rhines, which effectually frustrate the trespasser, unless he is furnished with a jumping pole or plank. The thickness of the osiers renders them impenetrable to sight, but the listener on their margin soon becomes aware of their bird inhabitants. A guttural, squeaky chatter rises from the herbage at the side of a rhine, and soon a sedge-warbler, with white eye-streak, and back striated in various shades of brown, appears, with "curses not loud but deep." Then, from amid the dense depths of the osier bed, comes a song, whose confused, husky burbling is relieved occasionally by piping notes, pitched higher, as though the singer were trying in vain to attain to loftier and more tuneful flights of expression. This is the reed-warbler. And then there breaks in upon this strident babel of banderlog talk, a song whose quality at once arrests and delights. Though its mode is that of the reed and sedge birds, there is in it a clear, liquid quality which at once distinguishes it from their gruff tones. It is the marsh warbler.

Its "sweet, silvery individuality," as Warde Fowler wrote of the song, makes it unmistakable. Marvellous impersonator though this little bird is, it is not a mere mimic. *Nihil quod tetigit non ornavit.* It refines. The hysterics of a blackbird, who thinks he has seen a ghost, are toned down when the marsh-warbler imitates them. The lapwing's peevish call when the young are about becomes even more plaintive, " more

condoling," as Bottom the weaver would say. To suggest that it is possible to improve the song of the nightingale or skylark would seem perilously near exaggeration, but at the risk of being dubbed too imaginative I will say that to me this warbler seems to reproduce them with a lighter touch.

If curiosity spurs the listener to try to obtain a glimpse of this mysterious and intriguing songster, he will soon find it a difficult task, for the depths of an osier bed are as dense as the jungle. Crouched among its undergrowth, he finds sunshine has become twilight; peeping along the rows he will catch sight for a few seconds only of a small brown bird with fawn coloured breast, and, if he is lucky, may identify the lighter shade of the legs which is one of the marks which distinguish the marsh from the reed-warbler. But, in the field, to separate the two, except by their voice, is almost impossible.

Heard at close quarters, the differences between the songs of marsh and reed-warbler are even clearer. The reed's monotonous reiteration becomes almost tiresome; but the marsh's lively performance is full of surprises; he keeps you wondering what he will do next. Upon the sibilant small talk of the osier leaves (for they chatter where pines whisper) suddenly bursts, almost at one's elbow, the scold of a blackbird; look round cautiously, and you will marvel to see that it proceeds from the throat of a mouse of a bird less than half the other's size. And there follows, from the same source, a bewildering medley of lyrical mimicry—the whitethroat's chuckle, the skylark's "silver chain of sound," the chirp of quarrelsome sparrows, the twittering of swallows in the eaves, goldfinches' glittering links of melody, the willow-warbler strain which "has a dying fall," the chaffinch's call notes, the blue tit's scold, the starling's bubblings-over, and a dozen other songs which follow each other too quickly for identification. The blackbird's inconsequential musings were once imitated so perfectly that they stirred him to emulation; he sang a stave himself, and it would be hard to say whose ballad was the more perfect.

Mimicry in bird song is a fascinating but difficult subject. Why do some birds imitate more than others? The sedge, as well as the marsh warbler, borrows from his neighbours, and so does the reed, though less successfully, and to a much smaller degree. The starling can parody almost any song (his gurgling sounds like lampoons, more than a little scurrilous; but he, at any rate, evidently enjoys them). And, again, is imitative song conscious or instinctive? Perhaps it is both, but the most honest answer is "we do not know." In the meantime we may be content to listen and enjoy.

World Airways of the Future.

By A. E. Blake.

Below is the conclusion of a survey of the world's airways. As in the previous article, which appeared in May 1927, the existing and projected routes are dealt with on a regional basis. The new line to India may be extended in the near future, when it is hoped to establish connexion with Australia.

THE Central European airway system, dealt with in the previous article, is characterized by a highly-developed area of operation and the comparative frequency of important industrial centres along its routes. Economic working thus takes the form of flying in short stages, often in competition with efficiently organized surface transport. There is little scope on the Continent for the flying boat or seaplane (except across the Baltic and to provide communication with the English Midlands) and in these conditions probably none at all for the airship. The Mediterranean, however, being intermediate between the Central European and Atlantic systems, provides ample opportunity for the employment of flying boats, and a limited scope for airships, owing to the comparatively short distances between stopping places.

The Atlantic system. On the other hand, the Atlantic is nothing but a highway, with few groups of islands which would justify or even allow a break in the long journey. The shortest crossing, between the Guinea Coast and Cape S. Roque, is over 1,500 miles in length. At a time when flying-boat construction appears to be enjoying an attention that compensates for many years of neglect, the possibility of the use of such craft on the shorter Atlantic crossings cannot be dismissed; but it seems probable that, for some time to come, their use will be restricted to expediting the carriage of mails and passengers by providing air services between intermediate island ports of call and the ultimate destination of the steamship. Its employment in this capacity has received the approval of the Argentine and French Governments, and a concession

has been granted to the Latécoère Company for the operation of a mail service from Toulouse to Cape Verde Islands (an extension of the existing line along the north-west African seaboard) and between Fernando Noronha Island and Buenos Aires, *via* Pernambuco and Rio de Janeiro. The mails will be trans-shipped to a steamer at each end of the long sea crossing, which should shorten the time taken to reach Buenos Aires to seven and a half days and, after experience has been gained, to four, when it is possible that the entire journey will be made by air.

By Airship to South America.

Many plans are being matured, however, for the inauguration of direct air communication between Europe and South America. One which, first advanced in 1920, has now reached the stage of obtaining an official concession from one of the interested Governments, is that of the Colon Compañia Transaerea, an enterprise in which German and Spanish interests are co-operating, and which has for its object the maintenance of a regular service from Seville to Buenos Aires.

A sea route of 6,000 miles in length is obviously one on which airships have an admirable opportunity of proving their utility, and it is proposed to use Zeppelin craft of 3,800,000 cubic feet capacity, with accommodation for forty passengers and ten tons of freight. The terms of the contract provide initially for the operation of a monthly return voyage and, later, a fortnightly service. The Colon Company undertake to institute the service not later than 1930, but it is understood that not only is it likely to be in full operation at an earlier date, but a preliminary voyage may take place this year. Extensive preparations will, of course, be necessary. After the payment to the operating company of slightly more than a million pounds by way of subsidy, the terminal airport to be constructed at Seville will become the property of the Spanish Government. The subsidy will be paid on results, with an annual maximum of about £200,000. The ground organization will include emergency mooring masts to be erected at intervals along the north-west African and South American coasts.

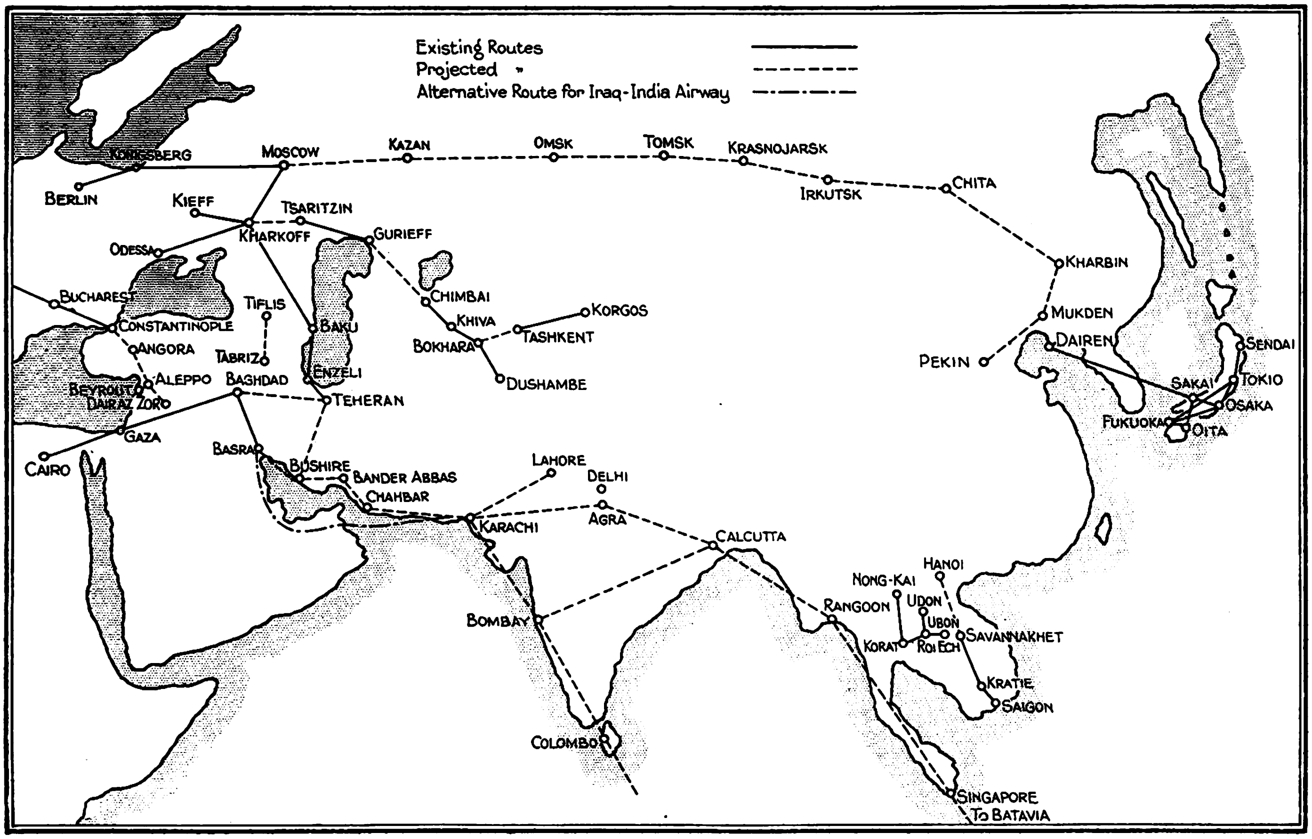
It is estimated that the time taken by the airship voyage will be less than five days, a saving of more than a fortnight in comparison with the time of the fastest steamship service. A subsidiary weekly service employing smaller airships capable of carrying sixteen passengers and a ton of frieght has also, under the Colon Company's concession, to be inaugurated between Seville and the Canary Islands.

The Asiatic system. Poorly served by existing means of communication, a continent of vast spaces, yet of dense populations and rapidly developing industrial activity, Asia should offer to air transport a field for exploitation as promising as any in the world. The Union of Socialist Soviet Republics was, until this year, the only power which had any substantial aerial achievements to its credit, but the disposition of such lines as Russia has instituted would appear to suggest a strategic rather than an economic objective. Kharkoff, which is connected to Moscow by an airway of nearly 500 miles in length, is evidently destined to be a centre of considerable importance in the air map of the Middle East. Lines radiate from this town to Kieff and Odessa in the west, while another, of 1,500 miles, runs to Baku and Enzeli, on the Caspian Sea. Dushambe, on the Afghanistan frontier, is to be the terminus of another line from Kharkoff, of which only the Tsaritzin-Gurief and Chimbai-Khiva-Bokhara-Dushambe stages are yet established. Tashkent and Korgos are also in aerial communication, and the extension of this line to Bokhara will bring the heart of Asia into touch with Moscow, and thence with Europe.

Of far greater importance from the commercial standpoint is the project sponsored by a subsidiary company of the Deutsche Lufthansa, the largest German concern, for an 8,000-mile airway across Asia to Pekin. This vast scheme has been the subject of a special two-months mission which flew the whole distance and has made its report. If the provision of such an extensive system of ground organization as would be necessary does not prove prohibitive, the benefits of such a service offer every inducement for its inauguration. Seventeen days are taken on the railway journey from Berlin to Pekin and, flying only by day, an aeroplane could accomplish the flight in five. The promoters seem very sanguine of success and have named 1929 as the year of the service's commencement.

The England—Australia Project.

By that time, it may be hoped, the British service across southern Asia to Australia will then be in full operation, although it has received a temporary check from the refusal of the Persian Government to ratify the agreement permitting regular operation of foreign aircraft along the eastern coast of the Gulf. The Indian Government has accepted in principle the recommendations of the Air Board that a vigorous development of Indian civil aviation is overdue. If the suggestions in the Board's report are adopted, the first step to be taken will be the initiation of a



MAP TO ILLUSTRATE THE AIRWAY SYSTEMS OF ASIA.

It will be seen that routes are already established in Burma and Siam, so that when the gap over India has been bridged, an overland route to Australia will be possible. At present there are diplomatic difficulties concerning flying over the Persian section, but an alternative route has been already planned by way of the Arabian peninsula.

600-mile flying boat service between Calcutta and Rangoon, to be followed by a link between Karachi and Calcutta, by way of Agra, that would complete 5,000 miles of the England-Australia airway and provide continuous communication between Cairo and Rangoon. It is proposed in the early stages that military flying boats of the British and Australian Air Forces shall maintain a service between Rangoon and Darwin.

In course of time the Indian terminal of the Indo-Egyptian airway is likely to be Bombay, rather than Karachi, while the Air Board advise early surveys in preparation for lines between Calcutta and Bombay and from Karachi to Lahore.

By next year the Dutch aircraft interests expect to have in regular operation a service linking their East Indian possessions. The existing Japanese system is reported to comprise lines between Tokio and Fukuoka, by way of Osaka, between Tokio and Sendai, Osaka and Dairen, and Sakai and Oita, while an ambitious programme of future development has been embarked upon.

An eastern state which has made greater use of aviation than many European nations of comparable size and greater wealth is Siam, which since 1922 has had in operation a weekly air service in both directions between Korat and Ubon, *via* Roi Ech, and extended the line in 1924 to Nong Kai. In the same year a branch line from Roi Ech to Udon was established. The system is operated by Siamese pilots of the Royal Aeronautical Service, who have been trained by French instructors and equipped with machines of French manufacture. Few countries have made so extensive a use of the *aérochir*, or " flying ambulance," as Siam, six of these machines being maintained for the conveyance of doctors, vaccines, and patients urgently requiring treatment for snakebite and fever, to the Bangkok Pasteur Institute.

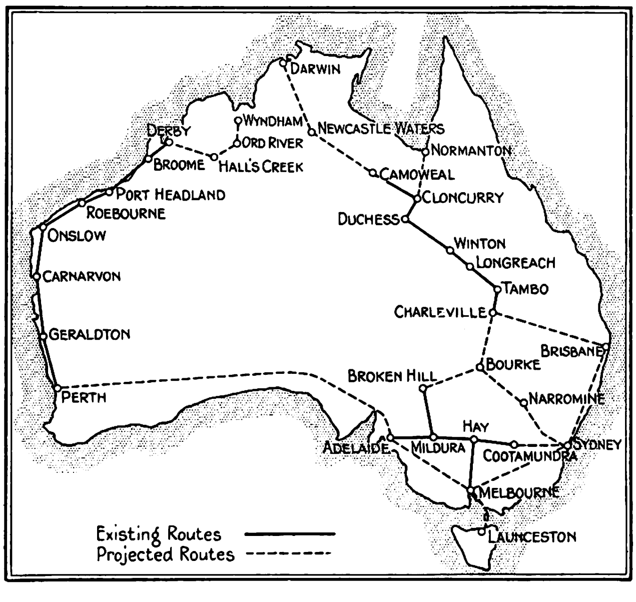
In the early part of this year the French have also promoted a weekly air mail service in their own province of Indo-China, serving the towns of Saigon, Kratie and Savannakhet. When this line is extended, as it is proposed, to Hanoi, the 800-mile journey is expected to occupy twelve hours.

The Australian system. No part of the British Empire has made so great an advance as Australia in applying aircraft to commercial use. The towns of

its western coast, from Perth in the south to Derby in the north, are linked by a weekly air service which until recently enjoyed the distinction of being the longest airway in the world. In the east, weekly services are also maintained from Camoweal to Charleville, a distance of 825 miles, and from Adelaide to Cootamundra. The last-named line is supplemented by branch "feeders" from Melbourne and Broken Hill over which machines ply twice a week to make connexion with the main service. The Commonwealth Government has called for tenders for the operation of an air line from Perth to Adelaide, which would connect the eastern with the western systems, while negotiations are proceeding for a flying boat service between Tasmania and the mainland.

The further extension of the England-India airway will demand the continuance of the Charleville-Camoweal link to Darwin, while other lines projected are those between Cloncurry and Normanton, Charleville and Brisbane and thence to Sydney, and Charleville and Melbourne.

The North American system. As in so many countries, the story of American civil aviation since the war is one of unrealized anticipations and of neglect. In spite of the incentives provided by its wide spaces and scattered populations, America has so far failed to develop commercial flying even to the extent of European powers with less spacious territories and far fewer financial resources. Even though great progress was undeniably made last year and the



THE AUSTRALIAN SYSTEM.

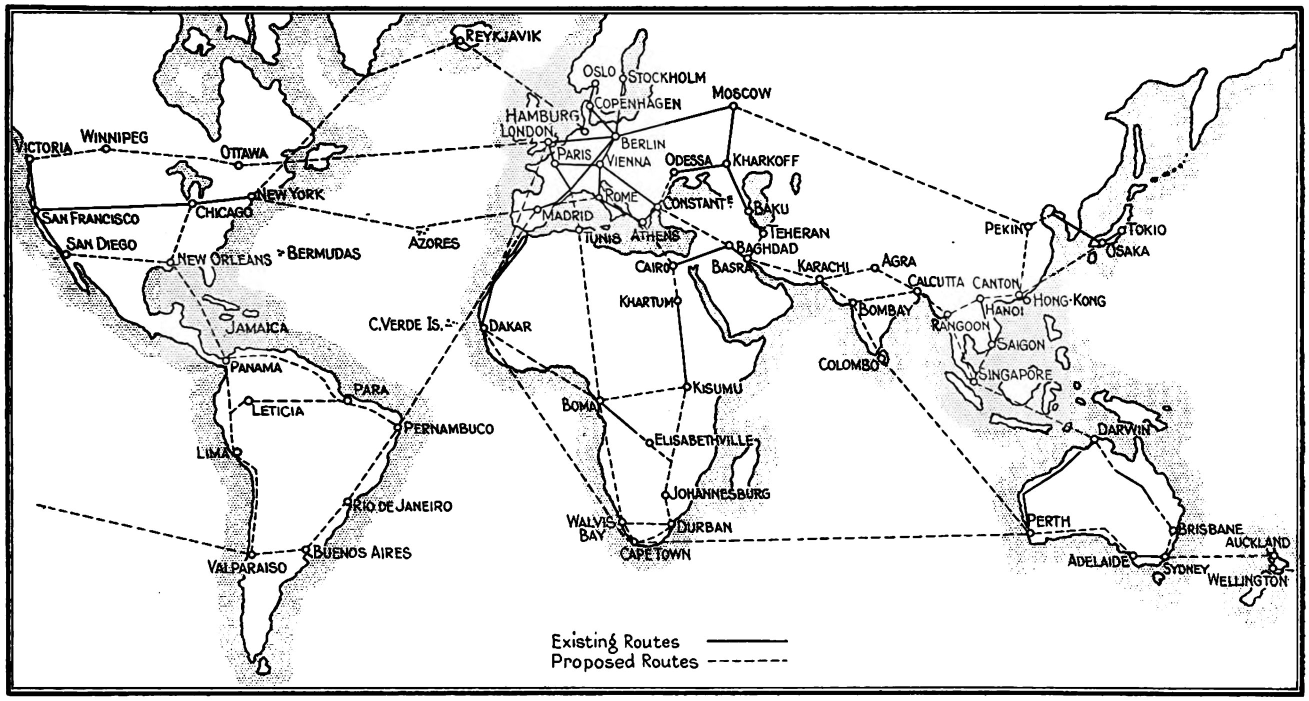
Without doubt Australia is the most developed part of the Empire where aviation is concerned, and large sections of the continent are linked by regular services.

lines now established challenge comparison, in point of length, with any in the world, they are used chiefly for the carriage of mails, passengers providing only an incidental source of income for a few lines and being entirely unprovided for on most. The great transcontinental line which spans America from New York to San Francisco, a distance of 2,665 miles, was, until this year, operated directly by the Post Office Department, utilizing a fleet of nearly a hundred Air Force machines. The carriage of the air mails is now undertaken by independent commercial companies, and subsidiary lines connecting the transcontinental with Seattle, Pasco, San Diego, St. Paul and Fort Worth are operated under contract in a similar manner. Many extensions of ambitious length are, however, projected and great activity is being displayed in equipping aerodromes with the lighting and other ground equipment necessary for night flying.

Air Mails.

Although mails have hitherto been the staple traffic of all the lines established, there seems no reason why urgent freight and passengers should not be as remunerative a portion of aerial traffic in America as they have proved in Europe or, in more comparable circumstances, in Australia. The factor which has hindered the development of these traffics in the States has probably been that the form taken by the support accorded by the Federal Government has been that of contracts for the carriage of mails. The contracting companies have, therefore, specialized their equipment and their schedules for this traffic, employing comparatively small, single-engined, open aircraft calculated neither to inspire confidence nor to provide comfort. The commission of multi-engined, enclosed aircraft, such as are becoming the standard passenger equipment on the European air lines, may be expected to open a new phase of civil aviation in the United States.

The Future World Airways. The regional method adopted for the foregoing survey of the world's airways may have obscured the contention with which the first article opened—that the full economic justification of aircraft lies in its employment over the longest possible distances, and that its function is to knit together nations and continents and not merely to promote political and nationalistic schemes aiming at exclusive regional development in times of peace, and capable of serving military ends in emergency. The map opposite showing the probable main air routes of the not very distant future may help to focus the whole subject in truer perspective. The



THE PRINCIPAL AIR ROUTES OF THE WORLD, PRESENT AND FUTURE.

use of Mercator's Projection may, however, cause one suggestive fact to be overlooked, and that is the potentiality of the Arctic and sub-Arctic in the development of aerial communication between the towns of the temperate belt of the northern hemisphere.

Stefansson, an enthusiast for the Arctic, is a warm advocate of this aspect of airway development. He claims that the Arctic, owing to the equable temperature of its long "day" and "night" would provide ideal flying weather for airships, which would be able to fly from northern Europe in spring or summer, cross the Arctic and penetrate some distance into Asia before encountering night. The fact that the journey from Britain to Japan, *via* Spitzbergen, Franz Josef Land, Emperor Nicholas II Land or Cape Chelyaskin, and thence overland, is 3,000 miles shorter than the route *via* Montreal and 2,000 miles shorter than the journey by the Trans-Siberian railway, is sufficient justification for a prophecy that the Arctic is likely to have a greater significance in the world airway system than this generation, over-familiar with the map according to Mercator, would be likely to consider possible.

The social and political implications of the airway form a subject too important and too suggestive to be relegated to a paragraph at the end of an article that has sought only to convey facts and to limit speculation to immediate possibilities. It is necessary to say, however, that just as the progress of civil aviation is conditioned by the readiness with which it is realized that the trade and customs regulations suitable to a sea-and-rail transport era are out of date in the aerial age, so the development of flying itself will help to destroy many hindrances to trade which the nations have erected on their frontiers. The benefits of aviation can only be bought at a price, and that price is the abandonment of insularity and selfish forms of nationalism.

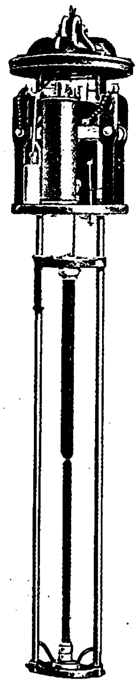
One may confidently predict that the cause of international peace is likely to gain from the progress of commercial air transport, not, perhaps, because contact between peoples always inclines them to like the other better, or, indeed, because the mass of the people will have the means to utilize directly the new form of communication; but because the intercourse that is promoted may minimize the disposition to credit the foreigner with those diabolical attributes that are an inevitable preliminary to war fever. It is an axiom of historical science that the rapidity and efficiency of communication determines the size of the administrative unit. It may not be extravagant, therefore, to suggest that a growing sense of the smallness of the world will in time make a war between nations seem as unthinkable as a present war would be between counties and provinces; and that through the agency of the airway the nations will gradually become more firmly united.

Recent Developments in Ultra-violet Irradiation.

By C. A. Cooper

The use of "artificial sunlight" for medical purposes has led to much research on improved methods, while ultra-violet irradiation also has interesting possibilities in its newest commercial applications.

ULTRA-VIOLET rays were first used in therapeutics by Finsen in 1893, and while progress was then slow, the experience gained in succeeding years led to artificial sunlight treatment on a considerable scale during the war. There are two reasons why these rays have unquestionable and precise curative powers. Firstly, they possess definite germicidal and bactericidal properties, with consequent blood purifying effects, and secondly, they exercise a highly beneficial influence on the nervous system. Unlike X-rays, their degree of penetration is only slight, about 1/16th of an inch through the skin, and during the exposure to them the blood conveyed through the capillaries and veinules is continuously subjected to the effect of the rays, wherever they are directed. The nervous system is similarly benefited through the ramifications near to the surface of the skin.

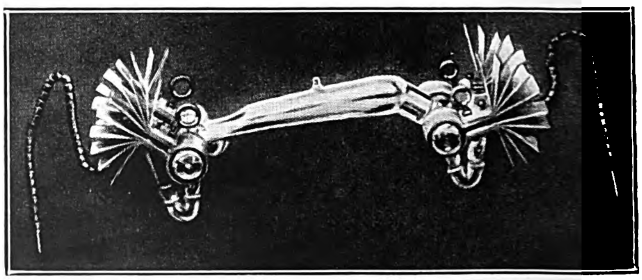


FINKEN BURNER 1893.

The most rapid strides have been made during the last few years, particularly quite recently, and I think that in the near future much greater scope will be found for this remedial agent, apart from its commercial and industrial use, which is speedily extending. Originally the endeavour was presumably to produce light giving the solar spectrum simply in order to replace natural sunlight. Long exposure was given to sufferers from certain troubles—rickets in children, tubercular affections, under-development, rheumatism, etc.—with good results, but it was appreciated that these could be much improved upon.

Means were sought to generate a more intensive volume of ultra-violet rays and various electric arcs were brought into use, increasing the range to 1,850 Angstrom units.* The mercury vapour arcs used for lighting purposes were known to generate ultra-violet rays, but the glass tubes obstructed their passage. It was found, however, that pure quartz, transparent and glass-like in appearance, *did* allow of the passage of all the rays, and thus evacuated quartz mercury-vapour burners were evolved and produced. This entailed great difficulty and expense because, unlike glass, this material cannot be reduced to a molten state, and only skilled craftsmen, who were restricted in number owing to the long training necessary, could fashion fused quartz at about 2,000 degrees Centigrade into tubing and then into burners.

As compared with natural sunlight, in which one can bask for hours on end, only from thirty *seconds* to five *minutes* exposure to intensive ultra-violet irradiation is possible, at say six inches to three feet distance from the source, because of the erythema set up with the same effects as sunburn. I must diverge for a moment from my theme to emphasize the importance of the dosage and distance of high power units in medical use. An "overdose" of natural sunlight merely causes redness, tanning and peeling of the skin, but overdoses of ultra-violet rays are both unwise and useless. Pigmentation and peeling of the skin, excepting in certain specific cases of skin diseases, have no therapeutic effect, and it is utterly useless to give further treatment until all traces of erythema have completely disappeared:



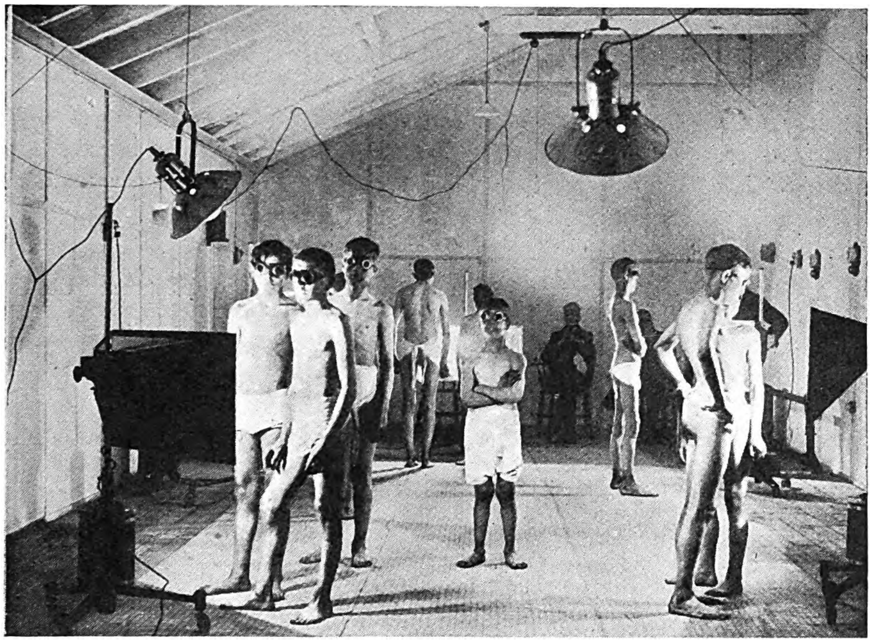
A MODERN ULTRA-VIOLET BURNER.

ultra-violet rays will not penetrate coloured matter even to the fraction of an inch, and reddened or browned skin is non-receptive, although coloured liquids such as blood do absorb the rays on the surface. Tanned or freckled portions of the skin, peeling or dead skin, and corns and warts, obstruct the rays, although by concentrating the rays on these growths,

* The Angstrom unit is used in expressing wave-lengths of light and measures one hundredth-millionth of a centimetre.

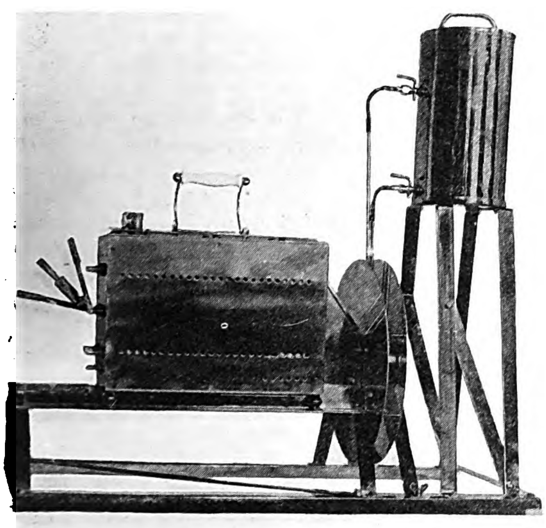
combined with the heat and slight volume of infra-red rays, they can be completely removed.

The latest theory which I believe to be nearer the ideal is that very *short* exposures should be *repeatedly* given. Instead of say three minutes treatment at thirty inches given once daily, the dosage should be one minute at three feet three times daily, thus preventing erythema or pigmentation of the skin and the consequent obstruction to the ultra-violet rays. Another method of equally recent evolution is to give treatment by the rays to the whole body in four instalments, so to speak, on consecutive days—the front of the trunk, arms and face the first day, the back the second day, and the front and posterior lower limbs on the third and fourth days, continuing the treatment in this order for a given period. Incidentally, as it is solely by the penetration of the rays through the skin to the blood and the nerves that the beneficial effects are obtained, it is always advisable to expose all parts of the body to the ultra-violet rays, and it must also always be borne in mind that they do not penetrate clothing of any kind.



ARTIFICIAL SUNLIGHT FOR MINERS.

Above is illustrated a " sunlight " clinic which has been installed at the pit head of the Sherwood Colliery, Mansfield, where miners straight from their shifts are given daily sun baths. Data are kept as to the health of the miners.



APPARATUS FOR TREATING LIQUIDS.

This apparatus is one of the latest applications of ultra-violet light now under research. The liquid is placed in a small tank between the circular vanes on the right. The rays pass through a water-cooled quartz lens, and the vanes, as well as the water, carry away the heat so that only ultra-violet rays reach the liquid.

Having described already the mercury vapour type of burner, I will now refer to other sources of production. Metals, such as tungsten, iron, and nickel, are prolific in the emission of ultra-violet rays when an electric arc is formed with them. Tungsten is very good, but it can only be used on " direct " electric current, and another drawback is the smoke from it. Many doctors nevertheless prefer it to the extent of installing special plant to use it when " alternating " current only is available. Even iron nails will give a good spectrum, either alone or combined with nickel or tungsten, but not exactly what is required, as the hand feeding necessitated is not practical and continuous variation in production is unavoidable.

Metal-cored carbons are certainly of immense value because pulverised tungsten, for instance, can be used with all electric currents. Special impregnated carbon rods are cast with a hollow centre into which various powdered metals are forced ; the carbon shell, treated for the purpose, burns evenly and steadily and the " core," whether of one metal or a mixture of metals, is consumed at the same time. Carbon arcs used for street lighting are so devoid of ultra-violet rays that they are useless for curative purposes.

In commerce and industry there is no limit to the possibilities of the use of these rays, from simple colour-testing to the treatment of foodstuffs. Philatelists can, with their aid, sort " the wheat from the chaff," for forgeries are unfailingly discovered

and fraudulent marks brought to light. The coloured material manufacturer of fabrics and ribbons can ascertain if his dyes are "fast" by simple exposure to the rays, and he can safely guarantee after such treatment that his products will not fade in sunlight.

Water is completely sterilized by exposure to ultra-violet rays, although the process is not exactly commercialized as yet because of the cost of the complicated plant necessary, which is not yet made on a proper production basis. There are also difficulties in manipulation and in checking results.

Finally, the treatment of foodstuffs is of immense importance, because of the increase of nutritive value. The illustration on page 61 shows experimental apparatus specially designed for increasing vitamin D in liquid foods; good food is made better, poor food is improved, and it is found that the ripening of fruit, cut while green, is hastened and attains a nearer stage to the real sun-ripened fruit. Bakers also are flooding their ovens with the rays; I have no data on this departure, but I am satisfied that there should be positive improvement in the food-value of the bread if treated while doughy, because, as with the skin, there is greater receptivity when dampness prevails.

I cannot here describe the various apparatus for generating ultra-violet rays, but a number of first-class British manufacture are already on the market.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

THE FACE OF THE SKY FOR FEBRUARY.

The winter constellations, Orion and Taurus, are now declining in the west, and the spring ones, Virgo and Bootes, appear in the east. Only one of the major planets is in the region of our map; that is Neptune, a little to the west of Regulus. February and the two following months are the best time of the year to look for the zodiacal light in the west after dusk. It is useless to attempt this in towns, an absolutely dark sky without moon being essential for seeing this very delicate luminosity; as its name implies, it lies along the zodiac, through Pisces, Aries, and Taurus. If it should be seen, the position of its edges among the stars should be noted as accurately as possible and communicated to some astronomer interested.

Composition of the Gaseous Nebulae.

The gaseous nebulae give a spectrum of bright lines, some of which have for a long time been identified as belonging to hydrogen, nitrogen, and helium; but there were some lines that could not be identified with any known substance, and a hypothetical gas was assumed to exist there, to which the name Nebulium was given. But the increase of knowledge concerning the atom has shown that there is no room in the element table for new elements, except perhaps a few of great atomic weight. It was then concluded that the Nebulium lines were really due to some familiar element in an unfamiliar condition. Professor H. N. Russell contributes an article to the "Scientific American" for January in which he explains the recent investigations of Dr. Bowen, which have traced the origin of nearly all the unknown lines as being due to the two gases oxygen and nitrogen, which between them compose about ninety-nine per cent. of our atmosphere. When gases are at ordinary pressure, or even at the low pressure of a so-called vacuum tube, the atoms collide very frequently, and change their amount of energy at each collision. In the course of these changes they pass occasionally through "metastable" states, in which they have given out nearly all their energy, and do not radiate light under ordinary conditions. But at the extraordinarily low nebular densities (a cubic mile containing less gas than a cubic inch of atmosphere) collisions are extremely rare, and the metastable atoms get a chance for radiating light before their condition is changed by a collision. The pair of lines at wave-length 3725, 3728, is due to oxygen in this state, while a slightly different state in the same gas explains the line at 4363 in the violet and a pair in the green. The strong pair in the red is ascribed to nitrogen.

It is to be noted that the explanation has been derived from the theory of the atom, not by actually producing the lines in a terrestrial laboratory. If correct it removes what was regarded as one of the greatest mysteries of celestial spectroscopy.

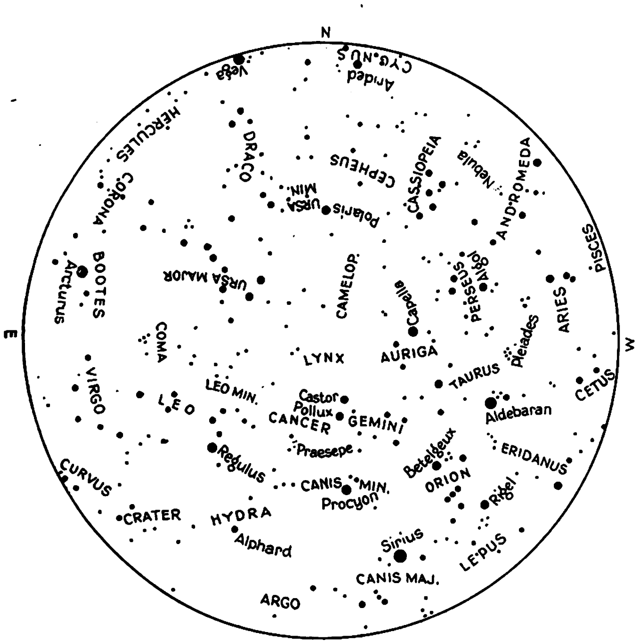
Photographs of Jupiter.

Professor Douglas, who took some remarkable photographs of Mars during the last two apparitions in light of various wave-lengths, has lately published similar series of photographs of Jupiter. The photographs give hope of determining the relative height of various marking; there are two ways of doing this. Firstly, the red images are notably smaller than the violet ones, showing that the outer layers of the Jovian atmosphere are opaque to violet light, but transparent to red. Secondly, photographs taken a few minutes apart, on combination in a stereoscope, throw the planet into relief, and cause the belts to stand out in three dimensions. One noteworthy point is that the great red spot is very strongly marked on the photographs in violet light, but almost invisible in those in red light, showing that it emits almost as much red light as the neighbouring parts of the disc. There are very striking differences between the distribution of light and dark regions in the photographs of different colours, and it should be possible to locate each marking at its proper height in the atmosphere.

A Tantalizing Comet.

A brilliant comet was discovered by Mr. J. F. Skjellerup of Melbourne on 3rd December; Mr. Skjellerup had already found several comets when resident in South Africa, but this is his first since he moved to Australia. The comet was of the third magnitude, and was in the south-east in the morning twilight. Its tail was three degrees long, its length subsequently increasing to eight degrees. There were at least two other independent discoverers of the comet, Mr. Ross Fitchet at Grahamstown on 5th December, and Mr. Maristany at La Plata on

6th December. It was 54° south of the equator when found, but was rapidly approaching the sun. On 15th December Mr. Chidambarier, assistant at Kodaikanal Observatory, saw it in full daylight within two degrees of the sun; it was then several times as bright as Venus at its brightest, and must have been of magnitude minus 5 or minus 6. Daylight observations were also made at the Lowell and Yerkes Observatories and in Germany. Unfortunately the comet did not come as far north o. the sun as was hoped from the orbits that were first published, and apparently only one observation was obtained in the British Isles by Mr. J. M. Patterson in Fifeshire. He saw it on Saturday afternoon, 18th December, from 4 to 4.15 p.m. in the direction south-west by south; it was clearly visible to the naked eye, brighter than a star of the first magnitude, with a tail of considerable length (about six times the diameter of the head). The orbit presented considerable difficulty in computation, as is generally the case in comets that approach near to the sun. Messrs. Wood of Johannesburg and Dawson of La Plata telegraphed elements when the comet had been observed for a few days, but these deviated considerably from the truth, through no fault of the computers. I had the advantage of a considerably longer series of observations, but still I do not claim the following orbit as anything more than an approximation. Perihelion passage 1927, 18th December, 18.61 Universal Time; Arc from node to perihelion 42° 56′, Node 81° 19′, Inclination 83° 52′, Perihelion distance 0.1822. or 17 million miles. The ephemeris shows that the comet remains near the sun till towards the end of February, and will then be best seen by southern observers. The orbit bears some resemblance to that of the bright comet 1860 III, but I don't think that identity is probable. When the comet was first found I thought it might be the return of De Vico's comet, 1846 IV, but the perihelion distance is too small for that to be possible. It is tantalizing that the brightest comet for many years should have passed without our being able to see it. There were ten comets discovered in 1927; the record year was 1925, with eleven; 1898 had also ten.



The Face of the Sky as seen from London at 8 h. sidereal time; at 11 h. p.m. on 5th February, and 10 h. p.m. on 20th February.

Correspondence.

X-RAY ANALYSIS OF CRYSTALS.

To the Editor of Discovery.

Sir,

On the second page of the January number of your magazine you make a generous reference to an account which I gave in a Royal Institution lecture of some recent work on the structure of the silicates. The advance is due to my son, Professor W. Lawrence Bragg, of Manchester University, and to his colleagues, as I was careful to explain in the course of the lecture. From your note it might be inferred that I could claim the credit for myself. I should be grateful if you could publish this letter so that your readers may be correctly informed on this point. It happens often, and naturally, that my son and I are confused with one another; we are both working on the subject of the X-ray analysis of crystals. But, as you will readily understand, I am most anxious that credit should be given where it is due.

My son himself gave a description of the results of his research on the silicates in a Friday Evening Discourse at the Royal Institution, which was subsequently published in *Nature* for 17th September, 1927.

Yours faithfully,

W. H. Bragg.

The Royal Institution,
London, W.1.
2nd January, 1928.

A LINK WITH OVERSEAS.

To the Editor of Discovery.

Sir,

As a former reader of *Conquest*, and now of *Discovery*, I look forward very keenly to my copy every month. Out here we live rather prehistoric lives. It matters not if the mail train is six hours late or three days during the rainy season—that's a mere detail, and when my *Discovery* arrives I look forward to seeing how things are going at home. The article in the September issue on the Bristol University was very interesting, as Bristol is my home town and when I left in 1920 they had just started building. Since I left home and arrived here, now nearly eight years ago, I have never set eyes on the sea, and I know of several people of twenty-five years old who have never seen the sea yet.

I should like to suggest, however, that we have a few articles, especially for overseas readers, dealing let us say with the latest "Underground" in London or the automatic telephone exchanges which I believe are being installed. In *Conquest* there used to be several articles during the year on the latest feats of engineering all over the world, and these seem now to have given way to discoveries of ancient men and buildings. Cannot we hear occasionally of something big done in Britain by Britishers?

Yours faithfully,

P. W. Nelson.

Bulawayo, S. Rhodesia.

(The policy of *Discovery* embraces a wider scope than the journal it took over, but our correspondent has anticipated this month's article on the automatic telephone. We welcome his suggestions, no less than his appreciation of Bristol, a notable achievement in another sphere of British home activity.—Ed., *Discovery*.)

Book Reviews.

The Army and Sea-Power. By MAJOR PARGITER, R.A., and MAJOR EADY, M.C., R.E. (Ernest Benn Ltd. 10*s.* 6*d.*).

It not infrequently happens that a reviewer lays aside a strategical book with thankfulness that his task of reading is completed, if indeed he has resisted the temptation to skim through its pages. "The Army and Sea-Power" is not, however, a book of this nature. Written in simple and lucid English, it traces the growth of English sea-power from its early beginnings to its culmination in the late war, and in such a manner as to render it not only a book of great value to students of combined strategy, but a book of engrossing interest to general readers, including boys who wish to know something of the sequence of events, the success and failure, and the ceaseless endeavour which has built up and utilized that sea-power. This book is therefore to be commended to all those who desire to obtain a brilliant little bird's-eye view of "sea-power".

It should not be supposed, however, that this is a "popular" book in the less worthy sense of that word. It tells a plain tale of success and failure which by its very simplicity sets forth the first principles of a sound Imperial strategy, first principles which we can only disregard at our peril. It is noteworthy that this able study of sea-power comes from the pens of soldiers, yet it is by sailors in particular that its lessons should be taken to heart. Few of us probably realize how great a part the army has played in the building up and maintenance of our dominant sea-power, and at the present time, as in the past, we have much to learn from those soldiers who appreciate not only what ships can do but, of greater importance, what ships cannot do and should not attempt to do.

The authors emphasize the historical failure of ships against shore defences, but has the Navy even yet learnt its bitter lesson? The necessity of the defence of Fleet bases by the Army is ably expounded, a necessity which the Navy certainly appreciates. Does the Navy, however, trust the Army sufficiently, or does it devote undue effort and material to local defence schemes of its own at the expense of fighting and mobile strength?

The success of combined operations is repeatedly shown to lie in surprise, and few, if any, examples are given of a successful landing from ships in the face of powerful and prepared opposition. The awful shambles that must arise from a landing in the face of modern weapons and defences should surely rule such operations out of any sound strategical plan. In the closing chapters, which deal with the late war, the authors pass over highly controversial matters with a light and unprovoking hand, realizing, as indeed they admit, that we are still too near these tremendous events to analyse them with that detachment which is so very necessary for sound judgment. It is in these closing chapters, however, that "The Army and Sea-Power" is most liable to give a not entirely correct impression of certain important aspects of the naval operations of the late war. The intense loyalty of the Army to the senior service precludes the authors from differentiating adequately between victory and non-victory in a great sea fight, and leads them into the common error of supposing that the Navy obtained the fruits of victory by the escape of the German Fleet intact into her harbours, with the eventual ignominious surrender at the close of the war. Nothing could be further from the truth.

While the terrible losses from submarines are legitimately compared with the losses we sustained in the Napoleonic wars from the action of frigates and privateers, the authors clearly share the widely held view that submarines are still a menace of dangerous proportions. They overlook, however, the startling limitations of these piratical craft when countered by the sound and unanswerable tactical defence of Convoy and Group-sailing, a method of defence introduced during the last ten minutes of the twelfth hour, and with dramatic results.

The Singapore scheme receives, perhaps, a greater blessing than it deserves, but it could hardly be expected that its strategical aspect would be called in question by military staff officers in the face of official naval opinion.

This book will interest and repay all readers, whether laymen, soldiers, or sailors.

B. ACWORTH.

Illustrations of the Methods of Reasoning: A Source Book in Logic and Scientific Method. By DANIEL S. ROBINSON, Ph.D., Professor of Philosophy in Miami University. (D. Appleton & Co. 8*s.* 6*d.*).

Old-fashioned teachers of logic seemed to take pleasure in emphasizing the formal aspect of the processes of reasoning, and in disguising the fact that, ordinary arguments being arguments about something, their cogency, or the reverse, is best illustrated for beginners in examples where this is evident from the subject matter as well as from the logical form. The alternative method, in which logical rules are disengaged from a number of examples in common speech, like any other scientific generalization, is more commonly employed in America than here; but Professor Robinson's book will be welcome as an auxiliary, both by lecturers and more enterprising students.

The plan of the book is fairly comprehensive, for it begins with the traditional Aristotelian logic, given in brief outline, with an ample list of examples under each head, and it ends with reprints of the chapter on the Methods of Experimental Enquiry from J. S. Mill's "Logic" and Tyndall's "Scientific Use of the Imagination." But the more characteristic sections lie between. Under the general headings, "Classification," "The Method of Sampling," "Statistics," and so forth, the principal stages of scientific procedure are stated in outline, supplemented by a short list of useful books, and illustrated by actual examples drawn from the newspapers, from specialist treatises of all kinds, and from that useful compendium of current discovery, the *Daily Science News Bulletin*, to which we have at present nothing analogous in this country, though it is satisfactory to note how large a number of these terse outlines of scientific procedure are derived from the columns of *Discovery*. Naturally, the largest series of examples is that which illustrates Mill's experimental methods, and the "complete method of explanation" where verification has been achieved subsequently. But the sections on "Analogy and Circumstantial Evidence" and the "Historical Method" are well furnished also, and will appeal to another class of students, in the "human" sciences. They are the more suggestive because historical analogies are associated with similar arguments in physics. In a second edition the "historical method" should similarly be illustrated from geological and palaeontological discoveries, and from evolutionary discussion of technological problems such as have been the life work of Pitt Rivers, Haddon, and Henry Balfour in England, and of Franz Boas in America.

It does not at all detract from the primary object of this book, that it is a feast of scientific gossip; and as the sources of the extracts are given, it is easy to follow up the subjects with which they deal.

J. L. MYRES.

Life in the Stars. By Sir Francis Younghusband. (John Murray. 10*s.* 6*d.*).

The author, in the course of his numerous expeditions to lofty mountains and lonely deserts, has had unrivalled opportunities for studying the majesty of the star-lit heavens; in recent years he has visited some of the great American observatories. The opening chapters of the book give a simple and poetic description of the important advances in sidereal astronomy that have been made in the present century, and the marvellous expansion in our conceptions of the size of the visible universe, and of the duration of the life of a star as a luminous body. He gives an outline of the hypothesis that the planetary system was formed by the expulsion of matter from the sun owing to the tidal action resulting from the approach of another star. He notes that such near approaches of stars to each other would be very rare, but that since our stellar system contains thousands of millions of stars, even if only one star in a million were the centre of a planetary system, there might still be thousands of planetary bodies in the stellar system that were suitable for habitation by high forms of living creatures. This cannot be claimed as a certainty, but few will be disposed to deny that it is a reasonable hypothesis. He elaborates his thesis from a variety of standpoints, and justly insists on the clear evidence of creative design that may be seen in the universe. He says "Surely it could not have been by a pure fluke that such a marvel as man arose out of the sun? Surely blind forces could not have produced so marvellous a result."

There are naturally a few points on which opinions will differ. Those who believe that "In the beginning God created the heavens and the earth" will dissent from his view that the material universe had no beginning, but existed from eternity. His assumption that the earth will remain a habitable world during the whole of the millions of millions of years that measure the life of a star (according to some cosmogonists) is unjustified. For the greater part of that long period the sun will give only a very small fraction of the light and heat that it now does; it is probable that its reduction to one half of its present amount would render the earth uninhabitable by higher organisms.

There are a few slips on matters of detail that should be corrected. On page 21 it is stated that the great American telescopes will photograph stars down to the thirtieth magnitude. This is too low by several magnitudes. On page 94 the author says that the combination of hydrogen and oxygen to form water cannot be effected in the laboratory; most of us saw the experiment performed in our school days. These, however, are trifles. The book as a whole is calculated to give an enhanced idea of the wonder and majesty of creation.

A. C. D. Crommelin.

Archimedes, or the Future of Physics. By L. L. Whyte. (Kegan Paul. 2*s.* 6*d.*).

To the young research student casting around for some niche in which to fit himself, physics often seems a worked-out subject. The mentalities and contributions of past and present physicists have set such a high standard, that the newcomer is a little fearful to tread on such august ground. To all such earnest people, this book will be an inspiration. The writer, blessed with that *rara avis* of scientific writing, a lucid style, has no illusions regarding the glamour and glory of physics, the infallibility of scientists worshipped as gods, or the theories which by constant repetition become laws. He is a clear and fearless thinker, and he solves the problem of the future development of the science in the common-sense manner, that is, by a careful consideration of the tendencies of the present. His writing has no taint of the modern method of prophecy. His method follows the lines of a true experiment—searching observation followed by an exhaustive and careful inference.

The two modern philosophies, introduced by Einstein and Bergson and elaborated by their followers, are shown to differ fundamentally in the question as to whether physical laws are reversible or irreversible. He holds a careful balance between the two, and his analysis shows that through Bergson's theories, physics will ultimately be allied to the biological studies, that is to say, the study of inanimate matter will assist in our understanding of the riddle of life.

J. F. L.

The Life of the White Ant. By Maurice Maeterlinck. Translated by Alfred Sutro. (George Allen & Unwin. 6*s.*).

This book is an essay after an extensive reading of the literature on the Termite, but unfortunately the author, who is not a biologist, has constituted himself a champion of certain views as to the psychology of these interesting insects and has apparently frequently lost himself in rhetoric.

The language, which, of course, is Sutro's translation, is beautiful and sometimes dramatic, but its meaning, if it has any, is often obscure. The first eight chapters are an excellent essay on the life and habits of the insect but, after that, we pass to the occult power, morality, destiny, and question of instinct and intelligence, and it is in these chapters that the author contradicts himself, praises the insect to the detriment of man asks innumerable and unanswerable questions, and is most pessimistic about everything, except the insect, which he regards as a very dirty but intelligent little animal.

He compares the termitary—and also the beehive and ant-hill —to a single individual, "with its parts scattered abroad" (p. 144), so that the Termite is thus a single immortal insect, and he says (p. 199) "for these millions of years the same insect has gone on living, with the result that not a single one of its experiences has been lost." Yet, referring to the human species (p. 165), he says, "When we think of the eternities that have been . . . there would seem no doubt that civilizations similar to our own, or vastly transcending them, have existed in other worlds and perhaps on this earth. . . . Do we ourselves derive any advantage? Perhaps we do; but the gain, if any, is so slight, buried so deep down in our subconsciousness, that we cannot readily trace it. And even if we could, there would be no sign of progress; but only retrogression, vain effort and barren loss."

On p. 165 he says, "a slight fall in temperature in the equatorial regions and the entire species (meaning the Termite) will be destroyed, . . . " But on p. 177 he suggests that change of climatic conditions may have caused the Termites to adopt a subterranean existence. On p. 176 he asks, "is . . . intellect itself any more than a name that we give to one of the spiritual forces that we least understand," whereas on p. 141 we find "we have not the smallest idea of what instinct is, whereas we do, rightly or wrongly, believe that we know something of the nature of intellect."

He says that all this earth has produced so far is "a nameless hopeless distress" (p. 180), and "why should that which never has been or never could be have any chance of ever living?" (p. 181), or again, "If this has never been done, what ground have we for hoping that it will ever be done?" (p. 166), and similar melancholic remarks.

He compares the polymorphism of Termites and their powers

of producing the right kind of individual according to the needs of the community, with human productions of machinery. " Is that not an invention that goes far deeper into the secrets of nature than the inventions of the telephone or wireless telegraphy ? " (p. 178).

Maeterlinck is not a Fabre because he is not an entomologist, but possibly some readers may regard this as an advantage !

FRANK BALFOUR BROWNE.

The Fellahin of Upper Egypt. By WINIFRED BLACKMAN. (George G. Harrap & Co. 15*s*.).

Miss Blackman's study of the modern peasants of Upper Egypt is an open door to romance. For six years she has lived in intimate touch with a people who have preserved their identity for five thousand years at least—a people who, though they lived at the junction of the eastern and western waterways of the Old World, and consequently were subjected to many cultural and racial admixtures, yet in the end were strong enough to breed out or subdue the foreign strain. In this volume, which is a book primarily for the general reader, Miss Blackman has recorded a small part only of the material which she has gathered, and yet still more remains to be done in the field. Here she deals with the everyday life of the individual, with his social environment, his industries and agricultural pursuits and festivals and some of his beliefs—magic, the medicine man, and the evil eye. In her chapter on Moslem sheikhs and Coptic saints she opens up a subject of great importance to which she proposes to devote a future volume. Her study of the women and children and the aspects of life in which they figure most prominently, birth, marriage and fertility, are specially important for the student of survivals and origins in view of the marked conservatism of women in such matters. The chapter on ancient Egyptian analogies, though again only part of the material, will show how much of Ancient Egypt survives if we only know where to look for it. When once this is recognized this material may afford a key to the meaning and purpose of many obscure relics of the beliefs and practises of the Ancient Egyptians. One instance must suffice. Clay balls containing infantile hair of which the purpose could only be conjectured have been found at El-'Amarneh and Lahun. Exactly similar balls containing the tufts of hair shaved ceremonially from the heads of young boys in performances of a vow are buried by the modern people outside the tombs of the Moslem sheikhs or Coptic saints at which the ceremony takes place.

E. N. FALLAIZE.

An Art Student and his Teachers in the Sixties, with other Rigmaroles. By W. S. SPANTON. (Robert Scott. 7*s*. 6*d*.).

The author, with engaging candour, calls this book a " rigmarole," and it would be hard to find a more apt description, provided we attach to that word its more kindly meanings, and reject the more defamatory. The dictionary will justify the assumption that a rigmarole is tedious, long-winded nonsense, but Mr. Spanton's writing cannot be stigmatized with any such epithets. But " disjointed talk " is equally a dictionary definition, and this certainly fits the case. Almost as though he were gossiping by the fireside Mr. Spanton has gathered together a series of fragmentary reminiscences which date back to student days, first at Heatherley's Art School and later at the Royal Academy. Many of the names mentioned are those of artists who subsequently came into prominence; others have been long since forgotten together with their nicknames and peculiarities of manner which he gives in detail. This kind of thing is full of interest to those whose memories can carry them back to the 'sixties and 'seventies. To others one feels that its value is less that of a matter of immediate concern than that of a reserve of illuminating information available if required. But the small volume contains much more than this chronicle of small beer (which as a beverage is good in its way though it doesn't get you much " forrader "). The very readable chapter on Charles Fairfax Murray is full of entertaining things about Rossetti, Burne Jones, William Morris, and the pre-Raphaelite atmosphere and, indeed, many other matters. It may be gathered, then, that the book is one which should be in the hands of all who are interested in the art history of the second half of the nineteenth century, and this, we think, may be truly said for it. But we feel bound to add that if it is to be of practical use to them they will need to make a far fuller index than the one provided. There are, to take an instance, numerous references to Ruskin whose name does not appear in the index at all.

C. E. H.

Hunting under the Microscope. By SIR ARTHUR SHIPLEY, G.B.E., F.R.S. (Ernest Benn Ltd. 8*s*. 6*d*.).

In this book are collected together some articles which Sir Arthur Shipley contributed to *Discovery* on microscopic organisms. For some while he had intended to print them in book form, and after his death the unrevised manuscript was found among his papers. Sir Arthur had, however, already named a collaborator in Mr. Carl Pantin of the Plymouth Marine Laboratory, who had worked with him on " Life," the popular introduction to biology published a few years ago. The editor has therefore had the advantage of knowing at first hand the author's methods, and the necessary revision has been undertaken in the way he would have wished. Thus, for example, in explaining certain technical terms a sentence or two is introduced into the text instead of as footnotes, which Mr. Pantin rightly remarks " break the reader's continuity of thought." The book, in fact, is a striking tribute to Sir Arthur's lucid writing. The articles were written over a period of more than three years, but scarcely any amendment has been needed, and the theme is maintained from one chapter to the next as if originally written for publication in collected form.

The Antiquity of Man in East Anglia. By J. REID MOIR. (Cambridge University Press. 15*s*.).

Mr. Reid Moir needs no introduction to readers of *Discovery*. His paper on the important excavations at Hoxne, which he carried out on behalf of a Committee of the British Association, will be fresh in their minds, and no further testimonial of his ability as a practical archaeologist and as an exponent of his results is necessary. In the present volume his work is of a more systematized character; but it is still in the main concerned with his own researches in the field, except when he deals with the Neolithic, Bronze, and later ages. Necessarily he does not confine himself to East Anglia. Prehistoric studies there are brought into relation with discoveries elsewhere. One such excursion outside the borders of his area, when he deals with the eoliths of the Kentish Plateau and the flints from Cantal in France, leads Mr. Reid Moir to the pregnant statement that he inclines to the view that there is evidence for the existence of man in the Upper Miocene, the stage in geological time preceding the Pliocene of the Tertiary Epoch, which, of course, goes far beyond what most archaeologists are at present prepared to accept.

This general survey of the present position of the study of prehistoric archaeology in East Anglia will serve at least one good purpose in bringing home to its readers Mr. Reid Moir's great services to the study of Early Man.

E. N. FALLAIZE.

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Editorial Notes.

THE excavation of the Hippodrome in Constantinople, of which we publish an account this month, has revealed details of the most imposing of these ancient structures. While no hippodrome in Italy or Greece has as yet been properly excavated, the special interest of the Constantinople example lies in its containing a complete record of the city's history for a thousand years. The work is under the supervision of Mr. Casson, who contributes our article, and is the first to be undertaken with the full permission and approval of the Turkish Government. Excavating in towns is difficult under the best of conditions, and without official support it would have been impossible in Constantinople to explore the ground adequately. One of the buildings not yet definitely identified was unearthed in the open space adjoining St. Sophia; it appears to fit the position of the Octagon, a building which played a prominent part in the great Nika revolt that was ruthlessly suppressed by Justinian. As was to be expected, the discovery of coinage has been particularly marked, and exact dating of the layers uncovered has been largely made possible by this aid.

* * * * *

It is unnecessary to add to the pointed summing-up with which the Lord Chief Justice concluded last month the libel case of Mr. Mitchell-Hedges, the explorer, who brought an action for libel against a London newspaper. The wider issue involved is whether such valuable bodies as the Royal Geographical Society are serving their best interests by allowing members the right to initials that are obviously open to abuse. Apart from the type of writer and lecturer who may use membership to impose on the credulity of the public, there are instances of abuse which are not so generally known. Only a few weeks before the law suit under discussion, we chanced to meet an assistant master at a typical preparatory school, who seriously suggested that, in the absence of a university degree, the "F.R.G.S." was valuable as a "qualification." The point arose quite by chance in a discussion on the status of contributors to *Discovery*, when we made perhaps exaggerated light of these particular initials; but in our acquaintance's opinion they had proved of material advantage in securing appointments. The statement issued by the Society on 20th February does not seem to us to meet the situation as adequately as could be desired.

* * * * *

The latest report of the Medical Research Council contains some interesting details of new investigations on vitamins, in particular on vitamin "D." There can be no reasonable doubt, from all the evidence now available, that the great majority of our population is suffering from a deficiency in these essential parts of food, a deficiency of which the economic loss is incalculable. The report gives a technical account of work by Dr. Rosenheim and Mr. T. A. Webster, that has led to the artificial manufacture of vitamin "D," the anti-rachitic vitamin until recently obtained only as a product of a living substance. This has been effected by treating a sterol with ultra-violet light, a research that was touched upon by Mr. C. A. Cooper in our February number. "For the first time"—to quote the report—"it becomes easy to examine the properties of this vitamin without complications introduced by the presence of its common associates in Nature." This will obviously aid investigation at many points, and interesting developments are likely to follow.

* * * * *

We heartily endorse the appeal on behalf of the Stonehenge Fund, which Viscount Grey made at luncheon given last month by the Lord Mayor of

London. About £16,000 is still required to protect Stonehenge from unsightly surroundings, and the Government has no power to buy land surrounding national monuments except such as is "necessary to protect them against predatory animals." In suggesting that when we speak of Salisbury Plain we think of something not only flat but open, Lord Grey recalled some lines in which Wordsworth spoke of "Sarum's naked plain." The word "naked" is the one to be emphasized, and the features that inspired this impression are now in danger. Nearly fifty years ago, when Lord Grey first visited Salisbury Plain, he saw on the horizon an object that field-glasses showed was the spire of Salisbury Cathedral. "To have one of the greatest monuments of the religion on which our civilization is based just in view of the monument of some prehistoric cult is," he said, "an interesting feature that ought to be preserved."

* * * * *

The need for finding some cure for the depressed condition of the agricultural industry has lately received so much attention of a political kind, that there is a refreshing note in some observations just advanced by Mr. Borlase Matthews. Himself a practical farmer engaged in large-scale operations, he suggests that agricultural production can be improved through industrialization by means of electricity. The results are contained in his new book "Electro-farming," where the case for electrification and its possibilities on a seventy-acre farm is worked out. Ignoring the convenience of electricity and treating the matter on a purely commercial basis, it is estimated that electric lighting would save £1 5*s.*; electric milking would save £11 13*s.*; cream separating by electricity would save £5 16*s.*; water pumping would save £6 8*s.* 4*d.*; an electrically-operated chaff-cutter would save £1 11*s.* 6*d.* This means a substantial saving even after 15 per cent. on the installation cost has been laid aside for interest and depreciation. This improved state of affairs has been brought about by only *partial* electrification, and every day further applications to agriculture—such as electric soil heating—are being evolved.

* * * * *

The dispute over the discoveries at Glozel has not yet ended, and M. Reinach continues to use every opportunity to express his disagreement with the verdict of the inquiry Commission. The article he published in *Discovery* was itself a masterly array of such facts as support his views, and he is now making the most of his opponents' failure to explain the occurrence of the site. The latest round in the "Battle" has been fired in a letter to *The Times* by Sir Arthur Evans, who gives new evidence that the objects were of recent date. The chief technician of M. Reinach's own museum, it appears, has now been sent by the French Minister of Education to make an expert examination of the objects; and he shows that the cylindrical borings of the stone implements have been executed by steel tools, the engraving equally by metal points, and that the finished surfaces of the stone axe blades also bear the undoubted scratchings of metal files. If this new report should be substantiated by other experts, the only remaining problem would seem to be a matter for the police.

* * * * *

In the early hours of 9th February, an image transmitted by wireless from Mr. Baird's London laboratory was picked up in New York. Television has thus triumphed over distance, and the Atlantic is conquered by yet another means of communication. Following this achievement, the Television Society has appropriately launched a journal called *Television*, which presents many aspects of this new science. It is, however, to be regretted that the first of a series of articles on future developments should be devoted to "Television in Warfare." Probably few discoveries are made which do not have undesirable as well as useful applications, but Mr. Baird himself has publicly expressed the hope that other peaceful uses may be found for his invention. In making this criticism we are not overlooking the argument that every additional horror should serve to make war less readily undertaken—in our opinion an argument closely related to the fallacy that preparation for war is the best defence against it.

* * * * *

The first winter air cruise, organized by Imperial Airways and due to leave London on 27th February, will cover over 5,500 miles before the "Silver Wing" machine returns to this country on 1st April. After a night's stay in Paris, the party proceeds on the second day to Bordeaux and Biarritz. The flight along the Pyrenees affords one of the most wonderful mountain panoramas in the world. After an extensive tour over Spanish territory, Tangiers is reached across the Straits of Gibraltar. Fez, Algiers and Tunis are among a dozen places to be visited in the north of Africa, before the Mediterranean is again crossed for Catania in Sicily, and thence to Naples and Rome. The organizers are confident of keeping to their time-table, as the weather conditions should be more stable than those prevailing on the cross-channel route. It is entertaining to note that this first air cruise should follow so closely the centenary of Jules Verne.

The Hippodrome of Constantinople.

By S. Casson, M.A.

The first excavations carried out with official consent on the Hippodrome of Constantinople, under the author's direction, have revealed details of the most imposing example of ancient buildings of this type. The internal history of this great city for a thousand years is now yielding to the spade of the excavator.

EXCAVATIONS in the centre of a thickly populated city are rarely carried out, because of their obvious difficulty. The projected excavation of the ancient market-place of Athens by American archaeologists involves the clearance of many modern buildings and, in consequence, much preliminary expense. The excavation of the Forum at Rome was more easy since the site was largely an open space before clearance, but, even so, much had to be pulled down. Usually the ancient sites of classical lands are deserted, like Mycenae, Olympia, or Delos. It is, then, the more to be wondered at that the Turkish Government gave permission for the excavation of a site in the heart of Stamboul, since the bulk of the site is covered by roadways and a small park, which are in continual use. That they did give this permission is due solely to an appreciation by the authorities of the scientific value of such work and to their desire to give opportunity for their monuments to be scientifically examined.

FIG. 1.

THE BATHS OF ZEUXIPPOS, NEAR THE MOSQUE OF AHMET.

Clearance of the space between St. Sophia and the Mosque of Ahmet has revealed a structure that proved to be the Baths of Zeuxippos. They were connected to the Hippodrome by a bridge.

The circumstances of such an excavation are naturally bound to be interesting, and all work on such a site is certain to be productive. The Hippodrome has a double value from the point of view of the archaeologist. Firstly, it was the most imposing example in antiquity of buildings of this type. No Hippodrome in the ancient world had so long or so exciting a life; and, curiously enough, although volumes have been written about the races and games of the ancient world, no single example of a Hippodrome either in Greece or Italy has yet been properly excavated. But, secondly, this Hippodrome in particular is of profound importance, because it is the epitome of the whole of the internal history of this great city for a thousand years, and because it was adorned and readorned by emperor after emperor with works of art brought from the dying cities of ancient Greece. Constantinople had no great central Forum as Rome had, and her Hippodrome served the double purpose of a place where public games and spectacles were seen, and also where all the chief events of the public life of the city, processions of triumphant generals, dethronements of unpopular emperors, riots of rival factions, and public punishments of malefactors, took place.

It was with no little excitement, then, that we turned the first sod of soil in March of last year. To archaeologists this initial ceremony is not merely a ceremony. Once the shovel is in the soil a formality of great value is achieved. The director or learned body responsible for the enterprise has staked a claim, and nothing can subsequently give away that claim to others except the expressed will and decision of the excavator himself.

Our task was a heavy one, because no previous investigators had left any work upon which we could base our plans. The dimensions themselves of the

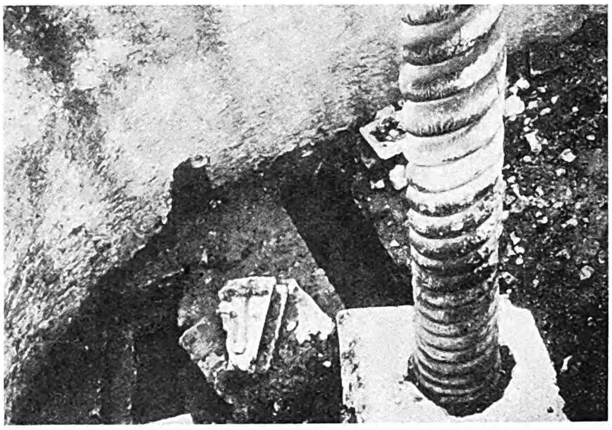


FIG. 2.
THE SERPENT COLUMN AFTER EXCAVATION.
Originally erected as a war memorial to the Greeks who beat the Persians in 479 B.C., this bronze column was afterwards used as a fountain. Water spouted from the serpent's three mouths, and the channel was found during excavation.

Hippodrome were utterly unknown, and all we had were guesses of various experts which varied sometimes by hundreds of feet; all that was left visible of the building was the row of three well-known monuments down the centre—the two great obelisks and the bronze serpent-column from Delphi—and a vast substructure in brick and stone at the curved end of the building which, in antiquity, was known as the "Sling" or "Sphendone."

But if we lacked information we had a surplus of advice. All the wiseacres of Stamboul crowded to the scene of action from the very first day and never left us. All, without exception, assumed that our talk of the Hippodrome was just our gentle bluff. It was *gold* that we were after, and someone had certainly told us where it was!—*they* could see through us; why, hadn't they been digging all over Stamboul for gold for generations? and hadn't they found it, too, every now and then? and now, here were these wealthy foreigners, with every conceivable implement and no police restrictions and goodness knows how many secret plans of hidden treasure in their pockets! They would not have a fiasco, as did the humble Turk who lived in the house at the corner of the square and dug so deep in his cellar that the house fell in on top of him. No, these foreigners would do the thing properly and in a few days, or at most weeks, they would get all the gold and jewels and be off!

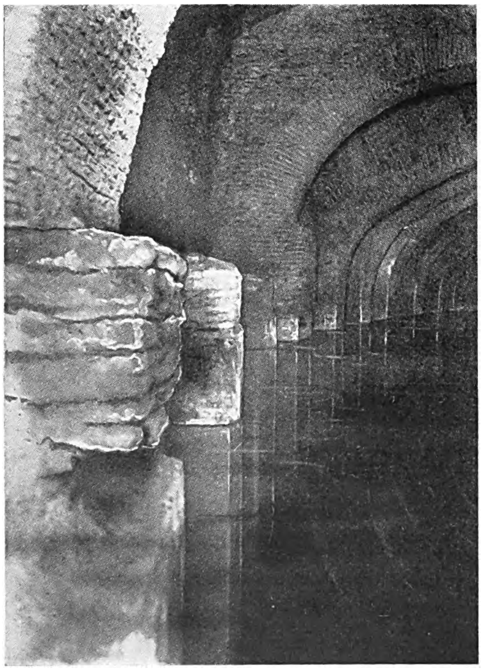


FIG. 3.
THE "SPHENDONE.'
This vast substructure of the Hippodrome was originally used for storing apparatus and animals for the Games. Later it was converted into a cistern, and the arches here seen reflected in the water were photographed by flashlight from a raft.

These were the thoughts of nearly every humble citizen of Stamboul. One came to me one day and showed me a piece of gold ore: "when you have finished here," he said, "come to my farm in Anatolia and help me dig my gold mine; I can see you are an expert." Another came and told me of a place "quite near by" where there were treasures galore. "Give me thirty per cent. of the proceeds," he said, "and I will show you the place." A third, a blind man led by a boy, came to tell me where there was a "hidden underground palace," and he offered (for a consideration) to show me where it was—the blind leading the avaricious! Then we had the local journalists of Stamboul, eager, anxious, and competitive, who called every morning and rang up every evening for ten days. No sensations being reported after this prolonged time they gave us up as a bad job, and did no more but make polite inquiries, as if we were invalids. For this relief we were thankful.

Our first two or three weeks were thus eventful and disturbed. But with neglect from the journalists and disappointment from the citizens, we at last achieved peace and faced our task with less exhaustion. No archaeologist can ever hope to move except at the most cautious pace, however slow that may be. A shovelful of earth too hastily removed may ruin evidence of the first importance. Excavators are like the detectives of fiction, who collect fluff off the seats of tramcars and dust off boots and keep it bottled and labelled; they are searching all the while for circumstantial evidence because that is all they ever get. The conditions in which an object is found are often more important than the object itself. The nature of soils and their stratification are the touchstones by which they will subsequently test their conclusions and fix their chronologies. If one knows the level at which a few coins are found and the other objects

with which they occur, one can date the level and the objects. The same coins merely picked idly from the soil may only be worth a few piastres; but well-authenticated as historical evidence they may necessitate the rewriting of many volumes. Hence in the long run indirectly they have a great intrinsic worth. So it is that the worthless cigarette stump will hang the murderer and save the expense of another crime.

Thus at first we dug the usual trial trenches at various points to establish the depths and so the history of the site. Then by gradual degrees we were able to find the main elements of the structure of the building. Our first task after commencing the preliminary trenches was to examine the substructure of the "Sling" or "Sphendone" (Fig. 3). The curved part was entered and found to consist of twenty-five large chambers, each opening out of a wide corridor that ran round the entire length of the building. Each chamber was about ten metres long and five wide. Five similar rooms were examined along the straight side on the south-east. All alike seem to have served as rooms for storing tackle, keeping animals and personnel for the games and similar purposes. Assuming that these chambers were uniform on each side, there would have been at least seventy-five along each straight side in addition to the twenty-five at the end. So that there was no dearth of accommodation for the purposes of the public games. One can thus get some idea of the magnitude of the spectacles given in the Hippodrome.

FIG. 4.
MARBLE RELIEF OF THE SECOND CENTURY A.D.
The figure of a sea goddess is holding a trident, with a dolphin in the background. It was discovered during excavation of the Baths of Zeuxippos, where such reliefs probably decorated the walls.

Once these underground rooms had been examined it was possible to get some notion of the width of the building. The side walls were therefore sought for and found in order to check this assumption. They were revealed by a deep cutting on the north-west side in an open but confined space adjoining the great military barracks that face the Mosque of Sultan Ahmet. They were cleared to their foundations, and in the process we again tapped the great corridor that runs round the Hippodrome (Fig. 5). It was completely filled with earth from which a very large number of coins were taken. The stratification of these coins gave us in summary the whole history of the building. The earliest were of the time when the Hippodrome was being built (the second and third centuries B.C.), and from the fourth to the eighth or ninth century they were plentiful. But after that they decreased in numbers, and by the time of the Crusaders they were comparatively rare. The inference is clearly that the people who passed along the corridor were less in number as time advanced. The great days of the Games when the crowds passed and repassed along this passage were over by the tenth century. Byzantines were too engrossed in their dangers and their political troubles and the imminent threat of the Moslems to care so much about their games. So too in the "Sling" we found that at some time, perhaps in the eighth century, the repeated invasions and attacks upon Constantinople had compelled the Government to increase the internal water supply in the city by transforming most of the twenty-five chambers and the corridor at the end into a huge cistern. This cistern survives (Fig. 3), and is still a water supply to the straggling slums in the region of the Kuchuk Haghia Sofia Mosque. We were compelled to carry out all our measurements of this part of the building by the aid of rafts and with acetylene flares. Often the raft precipitated us into the dark waters. From

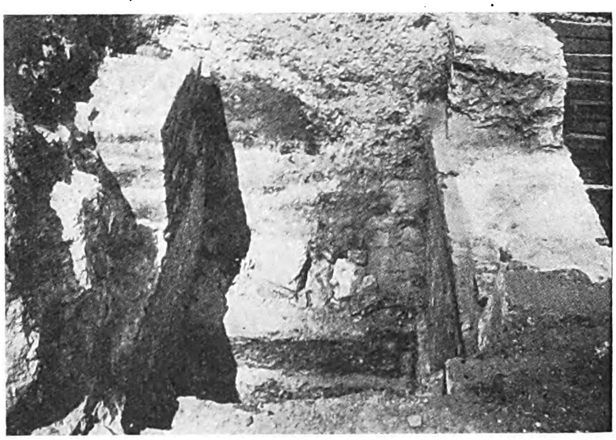


FIG. 5.
SIDE WALLS OF THE HIPPODROME.
The main corridor round the Hippodrome ran between these walls, which were found completely filled with earth. During excavation the many coins unearthed afforded a summary of the building's history.

the side walls we were able to calculate the width of the Hippodrome, which proved to be 117.5 metres exactly.

There remained the length. This we sought for by opening new ground in the open space between St. Sophia and the Mosque of Ahmet (Fig. 1). Here we found almost at once the massive columns of a building which was certainly not the Hippodrome, but which appeared to have joined it by a low bridge. A group of these columns was revealed which were so placed that it became evident that here were once the ancient Baths of Zeuxippos, which, as we are told in our records, adjoined the Hippodrome on the north-east. Soon we found a fine marble relief (Fig. 4), showing a figure of a sea goddess holding a trident, with a dolphin in the background. Other marble fragments were numerous, together with capitals of columns and fragments of columns. Byzantine pottery of great beauty was common—a welcome find, for little or nothing is yet known about the pottery used through all the period of Byzantine history.

A Great Rebellion.

The Baths seemed to have undergone some catastrophe, and to have been repaired later. On the bridge adjoining were five skeletons, three men, one woman, and a child. This, combined with the damage the building had suffered, led us to think that here was tangible evidence of the great rebellion of A.D. 532, the famous "Nika" or "Victory" riots against Justinian which his staunch general Belisarius bloodily suppressed by the slaughter of 30,000 men, women and children. We are told that the rebels held out longest in a building called the "Octagon." Perhaps we have found the Octagon itself; certainly its shape suggests the name. The flat gardens and open spaces that comprise the Hippodrome to-day thus hold much history beneath the surface.

Along the axis of the Hippodrome we examined each of the standing monuments. The first, the so-called "Column of Constantine Porphyrogenitus," provided a curious surprise. It rises some 32 metres above the ground, and is to all intent and purposes a mere obelisk. It is known to have been covered with bronze plates, and its basis was enclosed in bronze except where the stone bearing its dedicatory inscription is left open to view. We dug beneath this tall monument and found a passage large enough to hold a man. On entering this, which I did as soon as it was cleared, I found that I could look up a hole that ran up the vertical axis of the slender column. It communicated with four other holes that opened on to the sides. The basis of the column had, in short, held a fountain with four jets of water playing from each of the four sides. Lead pipes were found still in place.

In the same way the Bronze Serpent Column, which Constantine took from Delphi, and which itself was the war memorial of the Greeks who fought and beat the Persians in 479 B.C., had also been used as a fountain with water spurting from each of the three mouths of the serpent. An old drawing of this column made in 1574 shows it with all its heads intact. (Now all but the one in the Stamboul Museum are lost.) Old legends describe how the Serpent Column in Byzantine days threw jets of milk, water, and wine. This is a fanciful memory of the days when it was used as a fountain. Tradition is justified. We found the water channel that ran beneath it (Fig. 2).

One negative discovery was interesting. All authorities had always said that down the centre of the great Hippodrome ran a wall which divided the course into two parts and that the three existing monuments stood upon it. It is said to have been called the Spina. Actually no such wall had ever existed; we found no trace of it and no indication that it had ever been built. Thus the shovel destroys dogmas. The existence of the Spina had been assumed only because it was thought that in Roman Hippodromes there always was one. Now we know that at Constantinople at any rate it was absent.

Elesewhere we found a fragment of a Turkish wall some ten metres in length, composed almost entirely of marble architectural parts of the Hippodrome. A close examination of these marbles enabled us to reconstruct in general what the superstructure of the building had been. Capitals of columns, marble pilasters, and parts of an elaborate architrave told their story. By careful measurements we are now able to say that the Hippodrome must have looked as follows:—Upon a solid brick and stone foundation which contained the main corridor and the numerous chambers were built up at a gentle angle the marble seats. At the top ran a colonnade round the whole length. Upon the columns was an architrave which was decorated with medallions of bronze nearly two feet in diameter, joined together by a continuous strip of bronze. The total length of the building was 480 metres. More detailed measurements remain to be fixed by later excavations, and we are only at the beginning of our labours.

Amongst our isolated finds was an excellent Hellenic relief of a woman seated on a couch, in exquisite style. It is of the best Parian marble, and was found near the side walls. Besides the numerous Byzantine bowls and cups which were found, we were fortunate enough to get many examples of the finest Turkish

faience of the sixteenth century. Ware of this type is of extreme rarity. It was made largely by the artists who were encouraged by the great Sultan Suliman the Magnificent. It represents the most artistic period of Turkish history, the time when the most beautiful mosques and palaces were built.

We are only at the beginning of an arduous campaign. We have merely solved the first and simplest riddles. Many more remain. Other buildings adjoining the Hippodrome must be examined. One such, a magnificent cistern consisting of eighteen Corinthian columns, formed part of the mass of buildings that lay between the Hippodrome and the great Palace of the Emperors, which awaits the research of other explorers. There is a vast complex of underground buildings in Constantinople which awaits an enterprising archaeologist. The city is an untouched field. Now that, under the Republic, science is given a free hand, there is no end to the discoveries which await the scientists of all lands, and not least those of Turkey, who are taking a profound and learned interest in their own antiquities.

The Mystery of the Porcupine.

By Dan McCowan.
Naturalist at Banff, Alberta.

The habits of what is known as the " mystery animal " of the greenwoods of Canada present many problems, though the author's observations will upset the pretty legend that the porcupine is able to " shoot " its quills.

In North America the rodents or gnawing animals greatly out-number all other mammals. Ground squirrels, prairie dogs, and field mice are found upon the great plains of Canada, beavers and muskrats swim in the many lakes and streams, and high on the rugged mountain side is the home of the marmot and coney. The forests offer covert to tree squirrels, chipmunks, and woodrats. Included in the long list of sharp-toothed beasts which belong to this order are many whose manners are quaint and curious, whose habits and character present to the naturalist problems that may only be solved by close observation.

Outstanding in this large and varied group is the porcupine. Wandering through the coniferous forests at all seasons of the year, moaning and whining to himself, this mystery animal of the wilderness seems to have no aim or purpose in life, and remains aloof from all other forms of wild life native to his habitat. To mankind he is one of Nature's enigmas. His biography might well be illustrated with a series of interrogation marks, several placed at the beginning, many more at the end. The name porcupine means literally, " spiney pig." In mediaeval English the word is spelt " Porkepyn." At a remote period in Canada's history the animal was referred to as " Urson," probably a corruption of the word ursine, meaning bear-like.

CAUGHT UNAWARES.
A photograph of the porcupine taken from life.

A full-grown porcupine has a total length of about three feet, the tail measuring seven or eight inches, and the head four inches; the body girth varies from fifteen to twenty inches. When in good condition an adult specimen weighs about thirty pounds. There is little of beauty or grace in the general appearance of this animal: the body is clumsy and shapeless, the legs short and stubby. In walking, the feet are placed flat upon the ground in like manner to those of the racoon and the bear. To aid the creature in tree climbing, the soles of the feet have been provided with what might best be described as a " knobby tread " surface. The eyes are small and lack lustre, the facial expression being in consequence dull and unattractive. Front teeth that are long and chisel-edged are well adapted to the gnawing habits of the animal, but why these already prominent teeth should be of an orange colour is not readily apparent. A coat of fine silky hair, shading from light yellow to nearly

black, serves to protect the porcupine from winter cold and from summer sun. In appearance, the male and female are alike.

The most striking peculiarity of the porcupine is a highly specialized development of the under-fur into sharp pointed quills. These spines are white with black tips. The body, with the exception of muzzle, legs, and belly, is covered with these quills, which normally lie flat. If the animal be disturbed or molested they are raised by muscular contraction, into an erect and almost impenetrable array of bristling dagger points. The body quills vary in length from one-half inch to over three inches, those on the tail are the shorter but being stouter and more closely set. All are so slightly attached that, should the points touch and enter the skin of a molesting bird or beast, they are immediately freed at the base. Each quill point is so barbed that once driven into the flesh or hide of another animal it can only be extracted by the exercise of considerable force. There are close upon a thousand minute barbs on a quill; these when moistened curl outwards from the main stem in such a way that they are firmly embedded in the flesh of the attacking animal.

" Shooting " Quills.

Tales of the porcupine "shooting" his quills are entirely mythical; nor does the animal curl up into a ball when attacked. His usual method of defence is to guard the unprotected snout by thrusting it into a hole or under a log, to arch his back and to set his feet firmly, meanwhile erecting a myriad of needle-sharp quills. In such position he awaits the enemy's assault. His weapon of offence is the tail, truly an awesome bludgeon. Should the assailant venture too close, this club, with its cruel stinging spikes, swings with amazing speed and with great force. This extremely rapid movement of the tail, together with the fact that many of the quills are dislocated by contact, has probably been responsible for the widespread belief regarding the ability of the porcupine as an archer.

Owing to his very efficient armament, the porcupine is almost free from attack. The cougar, lynx, and grizzly bear will, if driven by hunger, essay to convert "spiney" into a meal, or the wolverine, with his usual indifference to danger, may attempt to combat him. The golden eagle, and even the great horned owl, have been known to attack him, but in every case his enemies have been the chief sufferers. The one carnivorous animal which has successfully overcome the defence of the porcupine is the fisher, a fearless and savage type of weasel found in many parts of Canada. Approaching his victim silently and stealthily, with a dexterous twist of his paw, he turns the porcupine over, then, quick as a flash, sinks his fangs into the unprotected throat or underparts. It is an extraordinary circumstance that the quills of the porcupine, capable of deadly hurt to most creatures, are apparently harmless to the fisher. So long ago as 1829 the eminent naturalist Richardson, who journeyed with Sir John Franklin through North-west Canada, observed and noted the manner in which the fisher kills and eats the porcupine.

Domestic Problems.

Feeding on the inner bark of trees, particularly of spruce and pine, the porcupine is responsible for the destruction of marketable timber. A very small quantity of bark, however, serves for a meal, and so the damage caused by these animals is not very extensive. It is fond of hemlock twigs and esteems lily pads an especial delicacy. In orchard regions it is accused of raiding fruit trees. It frequently does considerable damage to harness and saddle leather, if it happens to be in the vicinity of a camp, as it seems to find nourishment in the salty grease and oil of the leather dressing.

Little is known of the domestic habits of the porcupine. It is known, however, that the young are amazingly large and well-developed at birth. Indeed, a new-born porcupine is many times larger than a new-born grizzly bear. Secure in the possession of a formidable armament, the porcupine moves abroad freely in daytime and may often be seen sunning himself in a lofty tree-top. His favourite sleeping place is within a hollow log or in a rock cavity. With head in, the tail out the slumbering animal is in little danger from surprise attacks. Buoyed up by his hollow quills the porcupine floats easily, and can thus swim for long distances with but little fatigue.

In some regions the porcupine is protected by custom, if not by law, for it is the only food animal of size which can be readily taken by man without the aid of gun or trap. A person lost in the woods can obtain, with little exertion, an emergency ration that is not at all unpalatable. The Cree Indians of Alberta considered porcupine liver to be a great dainty. The economic value of this animal is small. In embroidering various garments the dyed quills are made use of by the Indian tribes.

When all has been said and written, there still remains the problem of Nature's use and place for this strange quill-clad creature.

Domme : A Secret of Old France.

By Moya Jowett.

In a picturesque account of a little-known town of Old France, the author discloses particulars of arrangements that offer readers an unusual holiday. The co-operation of a distinguished archaeologist is available.

DOMME is an old mediaeval hill town perched 500 metres above the Dordogne river, in one of the loveliest parts of France. Domme has been till now a secret to be guarded from charabanc owners and lightning tour conductors; but it is safeguarded by the fact that it contains none of the things so dear to those who like their hotels English and their casino handy. So let me warn all those who want perfect sanitation, subservient waiters with excellent English, and the other appendages of modern civilization, that they will not find them at Domme.

The Dordogne river in its young and turbulent days carved its way through the limestone rock and cut deep twisting gorges. Then it spent the countless centuries of its maturer middle age in thrusting the walls of the gorges further and further back, till now it winds its way through a wide and fertile valley backed by the steep grey cliffs. Sometimes the twist of the river brings it right underneath the cliffs, and Domme is built on one of these isolated walls of limestone. One stands on the edge of the town and sees the river stretching for miles each way far below. On the other side of the town the ground slopes gradually down, and beneath the old walls terrace-gardens go down to Cenac, the little village at the foot of the hill. Ardent spirits can climb up the cliff if they wish, but there is a new gradual motor road that satisfies most people. And Domme is linked to the railway by bus, and the market town, Sarlat, by a prehistoric steam tram. The tram runs quite safely, but the people who live along the roadside borrow the engine if they have any private shunting; and the engine-driver is always willing to oblige them.

DOMME: THE DELBOS GATE.
Photos by P. Daudrix, Sarlat.

Historically Domme is fascinating. Its two roads still go through the old fortified gateways before entering the town—and the broken wall still cuts the town very clearly from the terrace-gardens outside the walls. Domme itself is entirely built inside these walls, which surround it on three sides. The fourth side is a sheer drop to the river. In Roman times there was a camp at the foot of the hill, where Cenac is now. All over this district wherever there are traces of a Roman camp the place name end in "ac." The presumption is that ac is short for *aqua*—water—and means that the Romans found water there and placed their camp accordingly. In mediaeval times the country was covered with dense forests where wild animals and robber bands roamed at will. Therefore the only safe means of travelling and trading was by water down the great rivers of France. That is why every twist and turn of the river had its fort or castle; and these forts which protected the towns that grew up under them, safeguarded the rivers and reaped, in toll on the merchants, a small fortune for the baron.

Before there was any town to Domme, there was a castle, on one end of the plateau. Where the river disappears in the distance one can just see the next one eight miles away. The castle of Domme was, by reason of its position, impregnable. And it is easy to understand that unless the king were a very strong one, these barons did as they wished. They became so powerful that finally the king determined to break them; and by his energetic measures did subdue them. His method at Domme was interesting. He financed the building of a free walled city on the

top of the hill facing the castle, and he built the town of Domme, much as it is to-day, to keep the castle in check. And from that day till the castle was destroyed there was always war between those who held the castle and those who held the town.

The nearest castle up the river is Chateau Montfort. Simon de Montfort, the Frenchman who came to England and founded our parliamentary system to check the king, sowed his wild oats round Domme in no uncertain fashion. We know him as the altruistic baron, but they knew him as one who conducted a particularly fiendish massacre. In those days Domme was held by the religious fanatics known as the Albigenses. The massacre of the Albigenses may have been due to real religious fervour, but it is a coincidence that they were rich, and their extermination was a very profitable business to the pious gentlemen who killed them. Simon de Montfort's uncle headed the crusade, and they besieged and took Domme and exterminated the heretics.

The English territory in France stopped just short of Domme. Naturally he who held Domme could control river traffic. So Domme was taken by the English, and changed hands several times in the next two hundred years. In the guard-room of the Port des Tours, the main gateway, the soldiers on guard carved on the stone to pass the time. The little girl who shows the gateway points out a "dragon." But to English eyes it is curiously identical with the old English leopard or lion with his tail arched over his back, and surrounded by English roses. On the opposite wall is a representation of the fleur-de-lys.

Castle versus Town.

When the English were finally driven from France, Domme became embroiled in the religious wars, and belonged alternately to Hugenots and Catholics until a Hugenot captain took the town by climbing up the face of the cliff and up a well that goes to the top of the hill. He was never dislodged from Domme as long as he lived. For whenever the Catholic nobles began besieging the town, his allies went and attacked their castles, and they had to hurry home to protect them. These skirmishes were always complicated by the fact that the castle and town were never held by the same side, and this sort of civil war persisted till the town finally overthrew the castle and pulled it down.

To-day the descendants of all these Albigenses, English and French, Catholic and Hugenot adventurers live in their old town, which meant so much in feudal days, and means so little to modern industrial France to-day. The industries of the neighbourhood are principally wine making, *pâté de foie gras*, truffles, and walnuts. The people cultivate their terrace-gardens and live on what they grow. They are exceedingly friendly in a dignified way.

Sometimes when we have been walking in the country it has begun to rain and we have taken shelter in some farm or cottage. The floor is of stone, and all the cooking is done over a vast open fire of twigs. The next room contains an enormous feather-bed, and the whole place is as a rule unbelievably dark. But the wife will press home-made wine or strong black coffee upon the traveller, and will only accept a present "for the children" after much pressing. It is a hard life. There are no weekly wages from office or factory, but hard work in the garden or fields or in the millstone quarries.

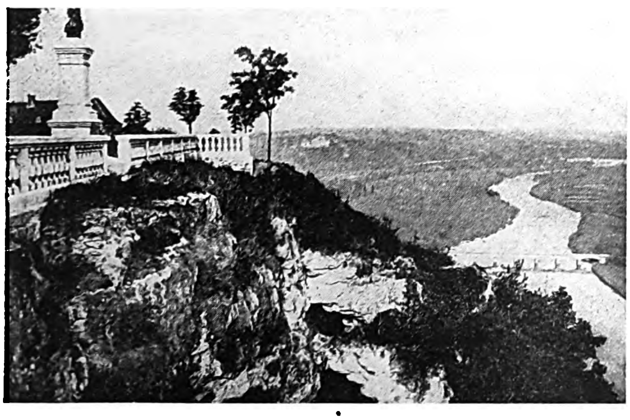
A Zacchaeus Legend.

Domme is within motoring distance of many places worth visiting. Besides the immediate neighbourhood, with the river to bathe in and the castles to explore, there is a wonderful drive up the valley of the Dordogne to that great place of Catholic pilgrimage Rocamadour. The legend is that Zacchaeus came from Palestine to France when the disciples were persecuted, and climbed the cliff face and lived and died at Rocamadour. Now, if one goes in solemn pilgrimage and climb the 300 steps from the valley to the grotto on one's knees, reciting the appropriate prayers, great indulgences are gained. The town of Rocamadour is built flat against the cliff, and the houses look as if they were built each on the roof of the other.

From there it is an easy drive to Padirac. Padirac is a real experience, and a little weird. It excites the hysterical to laughter and the thoughtful to silence. From the top there is nothing to see but a round hole in the ground, a great pit 100 metres deep. But at the bottom of the pit is another entrance that leads still further down to an underground cavern with a river rushing down the middle of it. There one gets into a boat, and is poled for nearly a kilometre down this astoundingly strange place. At the end it widens into a lake, and then one can walk still further and climb up to see the upper lake and the frozen waterfall that the water has made by flowing down to the river again. The roof is high and domed, and cleverly placed lights intensify the odd and beautiful shapes of the stalactites. The river, with its haunted suggestion of Kubla Khan, flows nearly another kilometre further than it is possible for visitors to go; and then it disappears and is never found again.

Many people have tried to find its outlet in some of the rivers above ground, but no amount of dye put in the water can be traced to any outlet.

I should never have discovered these places, nor yet the charm that comes from going simply into an unspoiled lovely neighbourhood and making it part of oneself, had it not been for two rather wonderful men. Mention of the name of Professor Patrick Geddes in England produces either a blank stare or a gleam of understanding interest. In France, India, Palestine, and particularly in the hearts of young people, he is a great magician who unlocks their imagination, and a wise friend who inspires their work. Professor Geddes visited Domme because his friend Paul Reclus lived there. M. Reclus is the quiet philosopher of Domme. Whatever the troubles, or joys, whether the problem is of business or psychology, all the good folk come to M. Reclus. It was Professor Geddes who saw the value of Domme with its wise man, and its nearness to that other great centre of inspiration Les Eyzies. Many specialists in small branches of research confine their interest to their own restricted area, and refuse to admit that it is feasible to attempt to synthesize these studies into one science. As a result of such a short-sighted policy, one eminent expert on flint implements destroyed half of one of the most beautiful friezes of prehistoric carving, because he had restricted his imagination to flint implements. Professor Geddes' desire, however, is to fit the prehistory of Les Eyzies on to mediaeval and thence to modern conditions in rural France, and so to present a whole picture. It is not necessary for me to describe Les Eyzies, as an excellent article on the caves, with their prehistoric rock paintings, appeared in a former number of *Discovery*.* And M. Peyrony, whose patience has made Les Eyzies the "Capital of Prehistory," is well known as the man who was in charge of the Glozel excavation inquiry.



THE VALLEY OF THE DORDOGNE.
Here viewed from Domme, on the side of the town which makes a sheer drop to the river, the Dordogne winds its way through a wide valley.

LA ROC GAGEAC.
The course of the Dordogne leads it beneath steep grey cliffs, of which the Gageac rock is seen above. At every turn of the river is a mediaeval fort or castle.

We have now "discovered" the Dordogne valley, and Domme with its beauty of red roofs and scenery. It would be easy for any reader to go on his own to Domme and Les Eyzies, and he will be amply repaid. But going alone one will not become one of the people and the place as is possible with M. Reclus. The ordinary guides will show all they know of the caves. But Professor Geddes dreamed of groups of people who would get to know the Dordogne through the kindly personality of M. Reclus, and by a special arrangement with the French Government should have M. Peyrony himself to illuminate with his vivid personality all the story of prehistoric man that lies locked in the rock shelters and caves of Les Eyzies. Tours of this kind do not pay, and it has been left to the enthusiasm of a group of young English people—the Kibbo Kift Kindred—and the generous support of the Wayfarers' Travel Agency to make this dream come true.

Since 1925 it has been possible for a small group of people to go both at Easter and in September, and the people of Les Eyzies and Domme are beginning to like their English caravans. The hotels are extraordinarily cheap, and as I have already mentioned that it is a wine, truffle, and *pâté-de-foie-gras* country, I need not dilate on the cuisine. If the tour is run with every comfort, the cost is sixteen guineas for the fortnight, inclusive of excursions and hotel accommodation, but by going third-class and camping it can be done for nine guineas. Should any readers be interested enough to write to me, care of the editor of *Discovery*, I would gladly let them further into the secret of Domme.

* "Les Eyzies—The Home of the Caveman." By E. N. Fallaize. July, 1926.

THE GOLD CUP DISCOVERED IN THE BEEHIVE TOMB

One of the finest known specimens of ancient gold work, this cup was discovered in the beehive tomb at Dendra. It measures about seven inches in diameter, and on its base octopuses are seen floating above a rocky sea floor. The surface of the cup is also decorated.

a half centimetres in diameter, and on two of them lions are seen pulling down bulls. As the bull is considered by some to be the badge of Crete, and the lion to be that of the mainland, it is suggested that the design may be allusive. At the king's feet lay other objects—knives, swords, spearheads—which are supposed to be the last offerings of his family and his officers, for the ritual of the interment seems to have been thus. When the long pit was ready and the king and queen were laid there in all their state with their more permanent personal property by them, their other more perishable personal belongings were heaped up on a wooden framework placed across a smaller pit alongside. Fire was laid to this to consume the objects, and as those paying their last respects to the royal pair filed by they dropped some object of value as a last tribute into the pit at the king's feet. They probably also poured a libation on the burning pile, because broken pieces of the same vases were found both in the grave pit and in the other pit. This may have been done to quench the fire as was apparently the Homeric custom. The study, cleaning, and repair of all the rich finds from this tomb, which dates from 1350 B.C. and is the only untouched beehive tomb yet found, is not complete, but the full scientific publication is now in active preparation for the Press.

In 1927 search for further tombs was made along the hillside near the beehive tomb. Though no other royal burial came to light, several rock-cut chamber tombs were excavated. The first two may be described as the ordinary good tombs of private persons of about the same period. The third tomb, however, was at once seen to be large and unusual. The entrance passage is twenty metres long and nearly two metres wide, and where it reaches the doorway of the tomb its floor is five and a half metres below the surface. The doorway itself, 2.30 metres high, slightly over a metre wide, and 1.60 metres deep, gave entrance to a tomb chamber 5.10 metres by 4.30 metres in area and 3.15 metres high. The roof, though part of it had fallen away, seems to have been of a saddle type, and is thus related to a series of fine chamber tombs at Mycenae, Argos, and Asine. The doorway had been blocked by a rough stone wall which had collapsed outwards as though someone had forced an entry to the chamber in ancient times. Under the fallen stones was a much decayed skeleton of a woman. This was associated with a few funeral offerings, including some objects of glasspaste once covered with gold leaf. These, if found by the plunderers, had been rejected by them, but the fact that the tomb seems to have been entered in ancient times gave little hope of any important find within. Fortunately, as was afterwards seen, part of the rock roof had fallen in, and so caused a collapse of the door itself, thus facilitating entry to the tomb, but at the same time, since the rock debris covered the floor to a depth of a metre and a half, effectually preventing the plunder of its contents.

DISCOVERY OF BRONZE OBJECTS
The removal of a stone threshold in one of the tombs revealed a large pit filled with bronze objects of the Mycenaean period.

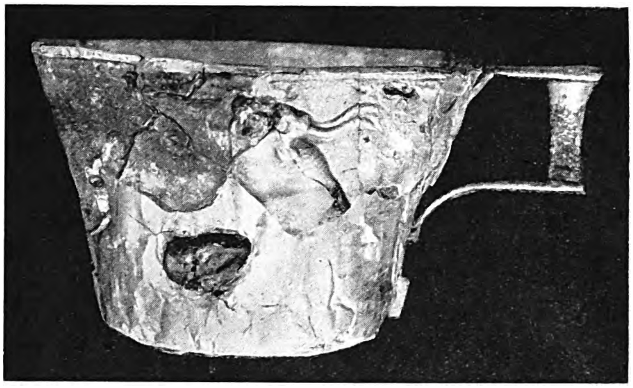
When the stone wall of the doorway was removed there came into sight at the bottom two large stones, making a kind of stone threshold. When they were raised a large pit, 1.60 metres long, .40 metres wide, and .90 metres deep, was found filled to the top with beautifully patinated bronzes, thirty-three in number, large and small. There were six hydriae, seven bowls of various shapes, four tripod cauldrons, five lamps, four mirrors, two knives, two razors, a spearhead, a sword, and a six-pronged fish spear. Several of the objects had exquisitely engraved patterns, flower and shellfish as well as purely linear designs, and the cleaning process will doubtless reveal many interesting details of this as one of the most beautiful bronze finds of the Mycenaean period yet made in Greece. Especially significant is the fact that a large portion of the objects—the sword, the knives, and the mirrors—have retained their original wooden hilts and handles. These have been properly treated to preserve the wood, which when first found was shrivelled and appeared undecorated. Now it has swelled out again, and one of the mirror handles which has some likeness to an ivory one from Mycenae shows two seated women, one holding a mirror the other a branch

OSTRICH EGG VASE.
The holes by which silver decorations were fastened to the shell are clearly seen.

of a tree. As far as Greece is concerned this find of carved wood is unique.

In the debris which covered the floor of the chamber a number of worked fragments of soft limestone were found. These were carefully numbered, collected, and removed. After careful sorting and examination four stone slabs were put together. First comes a sacrificial table two metres long, .85 metres wide, with square sinkings in the corners inside a high rim. Two notches, one on each long side opposite one another, probably had something to do with binding the victim on the stone. The second slab, 1.20 metres long and .80 metres broad, is hewn smooth on one side and on the other has a great number of similar square sinkings. Last come two slabs, 1.25 by .64 metres and .61 by .52 metres, which have incised grooves that recall the Nordic cresset stones. Each has a head-like projection at one end, a feature which suggests some figures from Troy. These two idol-like stones are probably menhirs. Their size, their shape, and above all their cressets, forbid any connexion with ordinary Aegean figures. Such stones have a wide distribution, especially in Scandinavia, Britain, and parts of France and Switzerland, and have been found elsewhere, but not hitherto in Greece. These two stones claim to be considered among the true cresset stones, and point therefore towards the north as does also the menhir shape. The meaning of such stones is much disputed. The purpose of these will be more clearly explained on considering the other finds in the tomb. Two hearths were found in the chamber; one made of small stones covered with plaster is against the inner wall, where two metres from the floor directly above it there are seven deep holes, apparently for fixing metal objects. The other hearth lies on the left of the door, and round both were plentiful traces of charcoal and other signs of fire, while on the wall by the first hearth or altar discolouration from smoke can clearly be seen on the rock.

The tomb was richly furnised with offerings such as three lamps of steatite, one over half a metre high, and four great alabaster vases, three of them Cretan and the fourth Egyptian. There were worked wild boar's tusks from a leather helmet, several gold jewels of filigree work representing shells, hundreds of ornaments of glasspaste with a great variety of patterns and all once covered with thin gold leaf.



EMBOSSED SILVER CUP.
One of the cups found in the king's tomb proved to be of the same shape as the famous gold cups from Vaphio, and like them it is embossed with a scene illustrating the chase of wild bulls.

There was a bronze sword with hundreds of thin white glass beads, which had evidently once been threaded and had formed a kind of beadwork on the hilt. Also there were found thousands of small glass beads, perhaps as many as forty thousand—white, blue, yellow, and brown. These were removed in hundreds as they lay close together and, as they were arranged in a design worked in coloured beads, perhaps once formed a beadwork corslet. This is the first definite evidence of the use of beadwork in Mycenaean ornament and will undoubtedly throw light on previous discoveries. A great deal of pottery was also found, and its evidence would appear to date the tomb soon after 1300 B.C. In the floor two small pits were found, and as that by the west wall was empty it had probably been found by tomb robbers. The other, .40 metres deep and one metre by .30 metres wide, was full of animal

A SACRIFICIAL TABLE.
This was reconstructed from limestone fragments found among the debris on the floor of the tomb chamber. At the corners are square recesses inside a high rim, evidently designed to retain the blood of the victim.

bones, ox, sheep, and goat, among which lay a silver cup, a sacrificial knife, an ivory flower with movable pistil, and an unusually beautiful carnelian sealstone with a design of two recumbent oxen in intaglio.

In spite, however, of the richness of the funeral offerings found in the tomb, there was no sign of any burial and no human bones at all. This extraordinary circumstance, taken in conjunction with the menhir and cresset stones, suggests that the tomb was a cenotaph. That it can have been intended for something other than a tomb is unlikely, for its plan and contents are consistent with those of ordinary tombs. We can only then assume that it is a cenotaph, and that the menhirs were intended to take the place of the body of the dead. They were roughly shaped to supply a material covering for the souls, and it is possible that in the absence of the bodies they underwent the same treatment which the bodies should have received, proper burial rites. If so, the person for whom the tomb or cenotaph was made would have perished at sea or abroad, and his body could not then have been buried by his kin. He would have to receive symbolical burial in order to provide a rest for his soul, and there are several Homeric passages which suggest this. When Telemachus sets out to seek his father Athena bids him if his father is dead raise a mound to him, and make offerings for the dead abundantly as is fitting. Menelaus erected a cenotaph for Agamemnon in Egypt, and Achilles did the same for Patroclus. The thought that lies behind the cenotaph is the calling home of the soul of one who has perished far away, and the preparing of a resting place for it in the empty grave. This would explain the hearth and the sacrifices, for the spirits of the underworld in the Odyssey came to the blood of the sacrifice Odysseus made for them. So when the souls in this manner had been called to the tomb, the offerings customary in the Mycenaean cult of the dead were brought to them so that they would rest there in comfort. Probably this anchoring of the soul in the tomb had a double purpose, that the soul of the dead, some great warrior no doubt, should be at peace and not wander abroad to harm the living, and at the same time should be close at hand to be invoked in time of need.

Sound in Modern Building.

By G. A. Sutherland, M.A.

Principal of Dalton Hall, University of Manchester.
Member of the Privy Council Advisory Committee on Architectural Acoustics.

The first large auditorium in England based completely on acoustic principles has been erected in London. Certain aspects of the science have yet to be investigated, but there is no longer justification for its neglect.

THE world in general, and the British Empire in particular, is full of "audience halls" which are often beautiful to look at but in which a speaker can hardly make himself heard. It used to be said, and even believed, that good hearing was a matter of pure chance, and the appearance of every new building that was more than ordinarily bad was made the occasion of repeating this dictum, and even adding the absurd statement that two *identical* halls could have quite different acoustic properties.

Yet in the middle of the last century the physicist John Tyndall presented a report to a select committee inquiring into the acoustics of the House of Commons, which showed that he was well acquainted with the principles of designing for good hearing. But the question was by him solved only in a general way, and it was about thirty years ago that the first systematic study of the problem was undertaken by Wallace Sabine, an American professor. With a genius for experimenting and great patience, Sabine was able to work out in detail principles of design and correction, and his results, though never published by him in book form, appeared in American architectural and scientific journals. It is a great tribute to Sabine's pioneer work that subsequent experimenting has served rather to confirm his conclusions than to introduce new results.

Yet, although this knowledge has been available for twenty years and has been extensively used in America and Germany, within the last few years legislative chambers and other halls have been constructed in every part of the British Empire, almost all of them in defiance of Sabine's principles, and the year 1927 has seen the erection of the first large auditorium in England whose design has been based almost completely on acoustic principles—the new Friends' Meeting House in the Euston Road, London, which seats fourteen hundred people and in which speaking may be from any part of the room.

When we speak of good hearing we mean, first,

uniform and *adequate loudness* ; second, *distinctness* ; and third, *accurate rendering*. In other words, the sound must initially be loud enough everywhere in the room, there must not be much overlapping between successive sounds, and the different simultaneous components of which every sound is made up must preserve their proper relative intensities.

Loudness.

Uniform loudness is associated in practice with the absence of curved walls. That this is so might be inferred from the fact that all "whispering galleries" owe their peculiar properties to curved walls or ceilings, and if there are special concentrations of sound in some places there are always corresponding deficiencies elsewhere. It is generally supposed that in the gallery at St. Paul's the sound is heard equally at any point round the wall, but if one ear be stopped it will be found that as the other ear is moved round the wall it will find loud and deaf points alternately. So for uniform loudness curved surfaces are generally best avoided. They can sometimes be used without detriment, but then their position and curvature have to be carefully selected.

Adequate loudness depends on a number of things. It has been said that the ear is so sensitive that, were there no disturbing effects, a speaker as far off as America could be heard in England. And the necessary intensity for hearing in any room is closely bound up with the distinctness attainable. In fact, owing to the increased distinctness attained by whispering, Sir Richard Paget has in certain bad halls been able to make himself better heard when he whispered than when he spoke in his ordinary voice. But as a practical guide under the conditions of rustling, etc., usually present in a large hall, we may take the 50 feet rule, *viz.*—that everyone within 50 feet of the speaker should be able to hear sufficiently well by means of the direct sound alone, and that those further away will require the assistance of sound reflected from some suitably placed surface. If the room is correctly designed the natural surfaces, walls, and ceiling, can be made use of for this purpose. Sometimes it may be necessary to introduce special splays.

Much the most important condition is that for *distinctness*, and the value of Sabine's work lies in his having been able to express this condition numerically and showing, also numerically, how it might be attained. Since indistinctness is due to the overlapping of successive sounds, it is clear that to produce distinctness the sound of any one syllable should die away rapidly once it has passed over the audience. This was accomplished automatically in the classic theatre, for there the sound simply escaped into the open. But in the modern auditorium it is thrown back by ceiling and walls and will produce either the distinct following sound we call *echo* or the confused prolongation of the sound known as *reverberation*. Excessive reverberation is much the most common defect in modern audience halls.

By a survey of different good halls in America and Europe, Sabine was able to show that satisfactory acoustics were associated in practice with a particular reverberation period, *i.e.*, the time taken for a sound of given intensity to die away to inaudibility. More extensive surveys on similar lines have shown that the allowable period varies with the size of room. It is also clear that since in music some blending of successive notes is desirable, the appropriate periods for speech and music will differ slightly. The desirable periods are given by formulae, and vary from 0.9 for speech and 1.1 seconds for music in the case of a room whose volume is 8,000 cubic feet to 2.0 and 2.5 seconds respectively where the volume is 1,000,000 cubic feet.

Sound Absorbers.

It now remains to consider how any given period may be attained. As we have seen, the quicker the sound can be got rid of, the shorter the period. Since the method of the classic theatre, the open-air method, is not available to us, we have to introduce into the rooms special materials to absorb the sound. The values of different materials and objects for this purpose may be gathered from the following table, which shows the fractions of sound falling on them absorbed by surfaces of different materials :—

Open window	1.00
Hard plaster	.02
Soft plaster	.034
Wood panelling	.06 to .10
Special acoustic plaster	.25
Heavy curtains in folds	.5 to 1.0
Heavy pile carpets	.3

Thus 100 sq. ft. of hard plaster will be equivalent to only 2 sq. ft. of open window, whereas 100 sq. ft. of suitable carpet may be as valuable as 30 sq. ft. of open window. For isolated units the following figures hold :—

		Sq. ft. of open window.
Hardwood chairs	each	.1
Upholstered seats	,,	1 to 3, depending on material and lining.
Persons	,,	4.7

i.e., an audience of 100 persons provides 470 units of absorption. The audience is much the most important absorbing factor in any auditorium, and this explains

why it is usually so much easier to be heard in a full than in an empty room. It will also be clear that if a room is to be used for a varying audience the acoustical condition cannot be the same at all times, but variations in the number present can be made to have least effect upon the condition by making the vacant places as absorbent as possible. In practice this means having well-upholstered seats and, for this purpose, the seats it is most important to cushion are those least likely to be occupied.

A very simple relation, $t = \frac{V}{20 A}$ holds between the volume of the room (V cubic feet), the time of decay to inaudibility of a sound of one million times the minimum audible intensity for the pitch in question (t seconds) and the absorbing power of the room, (A sq. feet of open window).

A is simply found by multiplying the area in sq. feet of every surface in the room by the appropriate fraction taken from the table and adding in the contribution of audience, etc. Then, if the value of t as calculated from the formula is too high, more absorbing units must be introduced until it is brought down to the required value. An example will make this clear.

Correcting a Music Room.

For a music room of volume 64,000 cubic feet the appropriate time of reverberation would be 1.4 seconds. Substituting these values in the formula $t = \frac{V}{20 A}$ we find that A works out at 2,286 units.

The absorbing factors in the room are

Plaster and glass,	78,500 sq. ft.	at .025	187
Wood	900 sq. ft.	at .03	27
Seats	400 sq. ft.	at .1	40
Audience	400	at 4.6	1824
			2078

This is short of the desirable number by 208 units, which could be made up by the substitution of special acoustic plaster for part of the ordinary plaster, or by the provision of a suitable area of heavy carpet in the gangways or of curtains on the walls.

The ear can distinguish as separate sounds which reach it at intervals greater than one-fifteenth of a second, in which time sound can travel 75 feet. This is the phenomenon known as echo, and in practice usually occurs with first or second reflections from distant surfaces. Such distant surfaces may be the ceiling if it is too high (over 40 feet) and the back wall. Such long reflected paths, tending to produce echo, may be got rid of by breaking up the surface producing them, usually the back wall, or lining it with absorbent material, or by raising the seats in tiers so that the sound which might produce an echo from the back wall never reaches it. The worst type of echo occurs with curved surfaces in a large room, for these produce sound foci, and it may therefore happen that the reflected sound reaching a particular point is more intense than the direct one. In a hall at the University of Illinois a speaker could hear ten such echoes of his own voice. When attempting to get rid of an echo by breaking up a surface, it is necessary to remember that whereas slight roughening is sufficient to make a surface a bad reflector of light, where the waves are about one ten-thousandth of an inch long, deep and wide coffering will be necessary to produce a similar effect on sound waves, whose length for musical sounds varies from about 3 ft. to 3 ins.

When we come to consider the third of our desiderata, *accurate rendering*, a complication is introduced by the fact that the materials in an auditorium absorb notes of different pitches to different degrees. Inasmuch as every musical sound is composed of a fundamental tone which gives it its pitch and a number of overtones of different pitches, the relative intensities of which give the note its quality, it is clear that the quality of the sound as heard will depend not only on the instrument emitting it, but also on the room in which it is played. With an eight foot organ pipe for which the overtones were pronounced in an empty room, Sabine found that the introduction of felt reduced the ratio of the first overtone to the fundamental by 40 per cent., that of the third overtone by 50 per cent., and that of the fourth by 60 per cent. With a six inch pipe, on the other hand, the effect was to accentuate the overtones, but all notes below the six inch fundamental were purified. The effect of an audience was quite different.

The musical effect will thus be injured or improved according to circumstances. The mixture stop in an organ is designed to be rich in overtones, the night horn stop to be specially pure; and it may happen that the room in which they are sounded will completely alter the intended effects. To determine the balance must lie with musicians, and the judgment of musical authorities should be gathered and made available. But so far as the writer is aware, this has not yet been attempted at all systematically.

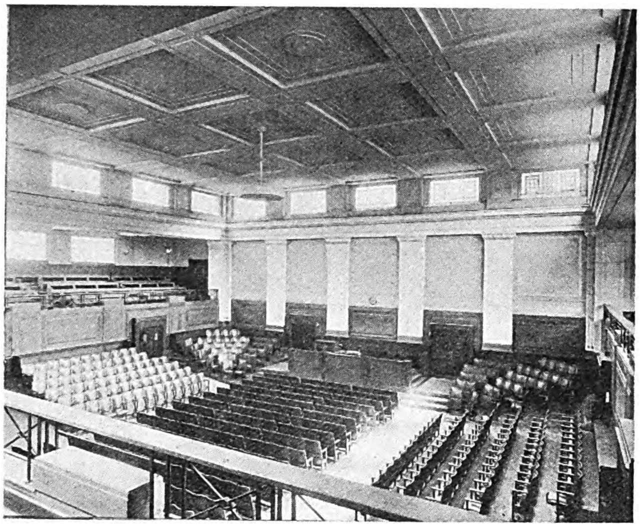
The type of room in which demands are most exacting is that in which speaking may be undertaken from any part. Usually this is a debating chamber, and the audience, besides being variable, is probably small for the size of the room, because of the necessity of providing easy access. Loudness and distinctness, always important, are here particularly so since the

speaker has some of his audience behind him, and there will probably be an exceptional amount of disturbance from whispering and from the noise made by members entering or leaving during a debate.

The direct sound should have an uninterrupted passage from any speaker to any member of the audience. This will mean raising seats in tiers and avoiding overhanging galleries. The ceiling is the best surface to use as a reflector, since it acts equally well in whatever direction the speaker is facing. It should therefore be made hard and reasonably flat, and to avoid echo must not be higher than 40 feet above the floor. In the new Friends' Meeting House referred to earlier these conditions are fulfilled. Usually when there are galleries it is well to have them under the main ceiling rather than under separate lower ceilings, but this is often impossible because of other considerations, and was so in this particular case. There is a good deal to be said for dispensing with galleries altogether and having the seats in continuous tiers. This is done with great success, I understand, in a Cairo Theatre, though the semi-circular plan of the seating there adopted is unsuitable for a debating chamber where speaking is not confined to a rostrum position.

As a debating chamber will not be used for music, a specially low reverberation period can be suitably arranged, and heavy carpets on gangways, in addition to the upholstered seats already mentioned, will not only assist this but also lessen the disturbance caused by entering and leaving. The Press may suitably be provided with seats in a well in the floor of the chamber and should have a separate exit staircase.

In conclusion, something may be said about popular ideas of the necessary conditions for good, and suitable remedies for bad acoustics. The most frequently

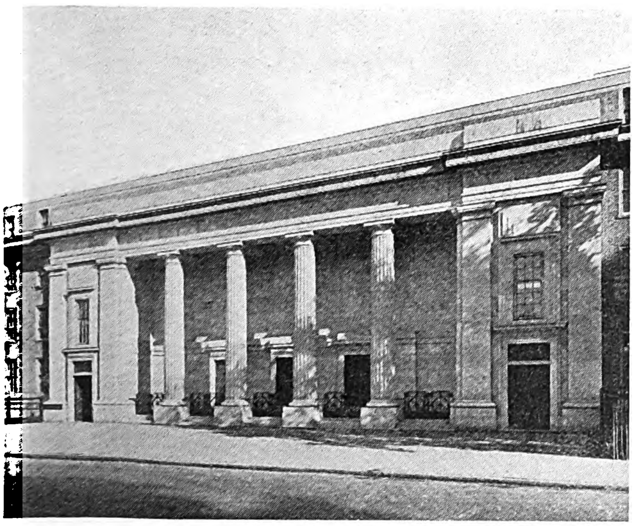


ACOUSTICS IN PRACTICE.
The auditorium of the new Friends' Meeting House, the first example in England of real acoustic design embodying noteworthy acoustic properties.

laid down condition for good acoustics is that the dimensions of a room should be accurately in the ratio 2 : 3 : 5. Some writers say 1 : 1 : 2 or 2 : 3 : 4. The exact origin of these ideas is not known, but from considerations advanced earlier in the article it will be seen that they are quite irrelevant. The shape of a room is within certain limits important, but there is no importance in conforming rigidly to this whole number standard.

The most popular remedies for bad acoustics are the stretching of wires in the room and the provision of resonant vases. What functions these were supposed to perform, and how they did so, are mysteries. Thin wires have as much effect on sound waves of length 50 to 5,000 times their diameter as a fishing line has on the waves of the sea. The idea to use vases probably arose because such vases have been found in classic theatres. The argument apparently was, "The classic theatre had good acoustics and the classic theatre had vases. Let us too have vases in order that we may have good acoustics." Apart from the fact that as arranged they could not possibly have accomplished this object, we have seen that the characteristic defect of the modern auditorium is the direct opposite to that of the classic theatre.

Sufficient has been said to show that designing an audience hall for good acoustics is now no matter of chance, but, indeed, that a room acoustically bad is quite inexcusable. We demand that a house shall be not only a beautiful place to look at, but also a beautiful place to live in, and we may rightly demand that an audience hall should not only be housed in a noble building, but should also be a beautiful room for hearing and speaking.



EXTERIOR OF THE NEW MEETING HOUSE

Searching for Island Galaxies.

By A. Vibert Douglas, M.Sc.
McGill University, Montreal.

The following is a first-hand account of a subject that is at present largely engaging the attention of American astronomers. The author suggests that the systems usually termed island "universes" are more adequately described in the title above, and he explains clearly the relation of the Einstein Theory.

THE knowledge that the heavens contain bodies that are neither planets nor stars is age-old, for the keen eyes of the star-gazers of civilizations long since gone did not fail to detect such objects as the nebulosity in the constellation of Orion and the small, hazy patch in Andromeda. But the significance of these objects remained a mystery for many centuries.

With the invention of the refracting telescope by Galileo about 1600, many of the apparently nebulous regions in the Milky Way were found to be resolvable into separate stars. These are so closely strewn in the sky that to the unaided eye their light is completely merged and blended. Towards the end of the seventeenth century, the second great type of telescope was devised by Sir Isaac Newton, namely, the reflecting telescope in which the starlight is brought to a focus not by a lens but by a mirror. About one hundred and fifty years later, when the small pioneer telescopes of Galileo and Newton had given place to large and powerful instruments, Lord Rosse discovered that a certain nebulous region in the constellation Canes Venatici when viewed through his great telescope was a cluster of many stars, and not merely a random, haphazard cluster, but distinctly grouped in the configuration of a spiral (Fig. 5). Thereafter the search for and discovery of other spiral nebulae became one of the most fruitful tasks of the astronomer. From that time to the present, as a result of ever-increasingly powerful instruments together with the introduction of photographic methods, many hundreds of spiral nebulae have been found.

FIG. 1.
ISLAND GALAXY (M. 64).
An early type spiral nebula in the constellation Coma Berenices. This and the other photographs reproduced with this article were taken at Mt. Wilson Observatory, U.S.A.

Speculation was at once begun. Could it be that all the nebulae were in reality close assemblages of stars requiring only yet more powerful telescopes to show each star separately?

Sir Wm. Huggins gave the decisive negative answer to this question—some of the nebulae are great clusters of stars, but there are others truly named nebulae, for they are masses of glowing gas having the type of spectrum typical of gas so hot that the atoms are radiating their characteristic quanta of energy.

Such is the nature of the Great Nebula in Orion, and of many other nebulae where vast regions of space are sparsely filled with gaseous matter. Where these gases are sufficiently hot, they radiate the distinctive wave-lengths of light associated with the atoms and molecules of which they are composed. Thus the spectroscopist identifies in these nebular spectra the unmistakable radiations of hydrogen and helium, often also nitrogen and carbon, and in addition to these he finds intense radiations which as yet have not been reproduced in the laboratory. They are probably due to some of the simplest gases radiating under conditions very difficult to produce in a laboratory. These elusive molecules are called "nebulium," and happy will be the investigator who succeeds in solving the mystery of their true nature.*

The gaseous nebulae are not all sufficiently hot to radiate; some of them glow only because of the proximity of very bright hot stars; others are so

* An editorial reference to the problem will be found at the conclusion of this article, on page 90.

cool that they absorb all the starlight that falls on them, thus forming great black patches in the sky. A famous dark nebula in the region of the Southern Cross is known as the "coalsack." A great American observer, the late Professor Barnard, has made a systematic study of these opaque clouds, of which he listed over one hundred and eighty, varying from very small patches with sharp outlines to the long irregular "dark lanes' so striking a feature of the constellation of Ophiuchus.

We know, then, that of the celestial objects called nebulae, some are vast clouds of gas occupying regions of space compared with which our solar system is absolutely insignificant, while other nebulae, in particular the spiral nebulae, are clusters of stars.

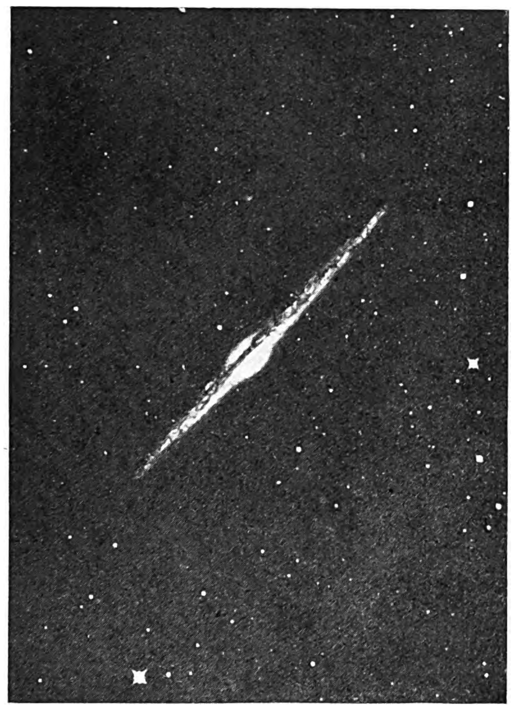


Fig. 2.
ISLAND GALAXY (H.V. 24).
Edge-on view of a spiral nebula in the constellation Coma Berenices. Five hours exposure. Foreground stars are in our Galaxy and the brighter ones are distorted by over-exposure.

For a long time no one had any conception of the immensity of spiral nebulae. They were thought of as comparatively small aggregations of stars within the great assemblage of stars surrounding our sun in all directions. The authors of the Planetesimal Theory drew an analogy between the arms of a spiral nebula and the arms of gaseous matter which they assumed to have been drawn out from the surface layers of our sun by the tidal forces produced by a passing star, these disrupted arms giving rise to the several condensations of matter which eventually became the planets of the solar system. Gradually, however, it became apparent that a spiral nebula was not to be compared with the solar system, but rather with the whole galaxy of stars—our sun and the thousand million other suns which stud the heavens all around us.

There are known to be many thousand spiral nebulae, and if each be comparable in size to our whole stellar galaxy, it is obvious that they are not within it. They are, in fact, *island galaxies.* The term is here used to denote exactly the same thing as the term Island Universes which has become so common an expression in American astronomical writing. Since "Universe" is defined as "all that exists, the creation and the Creator," its use in the plural seems unfortunate, especially as the word Galaxy is quite adequate. Dignifying our stellar system by the name *the* Galaxy—not merely because it is the system to which our sun belongs, but for the more logical reason that as yet no other aggregation of stars is known to be quite as large —it then becomes natural to divide all nebulae into two main classes, termed respectively the *galactic* and the *extra-galactic* nebulae.

Our galaxy is a gigantic aggregation of stars and gaseous nebulae. It comprises all the stars visible to the naked eye and the many thousands more revealed by the telescope when used visually. These numbers are multiplied many-fold by the use of photography when stars so faint or so remote as to be invisible leave the impress of their images upon the sensitive plate after many hours of exposure. The study of these photographs, counting the numbers of the stars of different magnitude or brightness, and comparing the numbers in different parts of the sky, has shown that it is possible to make an estimate of their number and a representation of their distribution in space.

Even with the unaided eye it is evident that the distribution of stars is not spherically symmetrical. All along a great circle in the heavens the stars are more numerous than elsewhere, and this encircling band is called the Milky Way. The photographic plates reveal the same concentration, and so the Milky Way is called the galactic plane, while the directions at right angles to this plane, where the stars are less numerous and on the average less distant, are termed the galactic poles. Our sun happens to be situated not far from the centre of this great lens-shaped cluster of stars. The dimensions of the galaxy are so vast as to be best appreciated when expressed in light-years, the unit so frequently employed by astronomers, equivalent to nearly six billion miles. Our galaxy is approximately 100,000 light-years across the galactic plane, and about one-fifth as much measured towards the galactic poles.

In this vast region, at great distances one from another, there are thirty thousand million stars,

FIG. 3.

THE GREAT NEBULA IN ANDROMEDA (M. 31).

One of the least distant of the Island Galaxies, just visible to the naked eye; it is made up of some thousand million stars and much gaseous matter, and is the best known of these bodies.

according to the most recent calculations reported by Dr. C. G. Abbot of the Smithsonian Institution, Washington. As these are by no means equi-spaced, there are concentrations of stars here and there which, seen from another part of the galaxy, produce such beautiful effects as the "star-clouds" in Sagittarius or the "globular clusters" in Hercules and other parts of the sky. Within the galaxy, too, filling great regions of space around and between some of the stars, are the gaseous nebulae both dark and bright.

Returning now to the extra-galactic nebulae—the great gaseous objects and star clusters like islands in a three-dimensional ocean of space beyond the Milky Way—we are indebted to Dr. E. P. Hubble of Mt. Wilson Observatory for much new knowledge concerning them. In a recently published paper* he has given the results of a careful study of four hundred such nebulae. Some of the extra-galactic nebulae show no regularity of shape or structure. These form a sub-class by themselves, and to this class belong the Magellanic Clouds, great irregular star-clouds visible from the southern hemisphere like detached portions of the Milky Way, though actually as far away again. Far more numerous than the irregular nebulae are those having a definite shape or structure, the ellipsoidal and the spiral nebulae. The spectra of the former are so similar to the solar spectrum that there is no room for doubt that they are clusters of stars, even though the individual stars cannot be photographed. Possibly the stars are being gradually condensed out of the gases of which the nebulae were composed, and the residual gases act as envelopes rendering the star images indistinct.

Some of the nebulae are apparently at a transition stage between ellipsoidal and spiral, while yet others display well-developed spiral arms. The evidence seems strongly to point towards an evolutionary process as a glance at the illustrations will make clear—the gradual unwinding, the appearance of stars and star streams, the whole vast process of the development of island galaxies.

With this idea of progressive development in mind, the spiral nebulae are said to be of *early*, *intermediate* or *late* type, according as they present the appearance

FIG. 4.

SPIRAL NEBULA (M. 101).

A very beautiful Island Galaxy in the constellation Ursa Major Four hours exposure.

* "Extra-Galactic Nebulae." E. P. Hubble. *Astrophysical Journal*, December, 1926.

of the uncondensed nebula in Fig. 1, or intermediate forms between that and the well-developed, far-flung, stellar arms so clearly shown in Figs. 4 and 5.

The distances of some of the spirals have been determined in a very interesting way. These spirals contain stars, known as Cepheid Variables, whose light is not steady but fluctuates with perfect regularity, falling slowly from maximum to minimum and then rising rapidly to maximum. The light cycles usually have periods of a few hours or a few days. When studying similar stars whose true brightness was known, Miss Leavitt of Harvard Observatory discovered the fact that the longer the period of light variation the greater the intrinsic luminosity of the star. This relation was well established for the less distant stars, and it seemed so logical to expect stars with identical characteristics to obey the same law whether near or far, that it has been applied to stars in these remote galaxies. From a series of photographs, the period of light variation is found, then the established relation gives the true luminosity, and this, together with the apparent brightness on the photographs, gives the necessary data for calculating the distance.

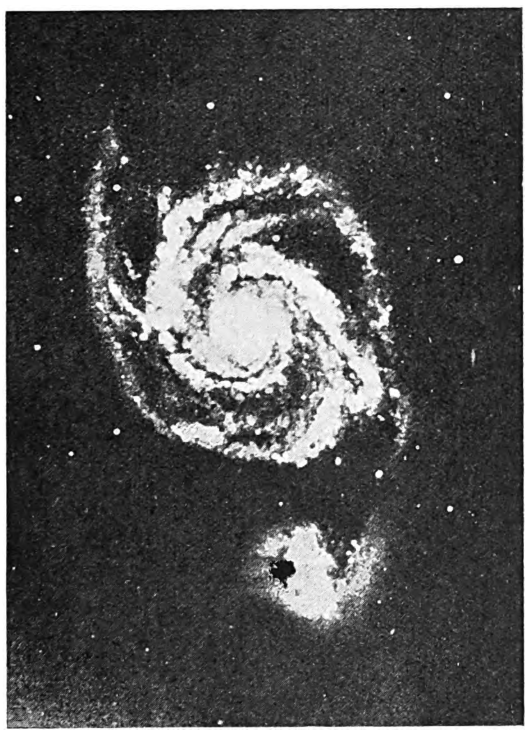


Fig. 5.
THE WHIRLPOOL NEBULA (N.G.C. 5194-5).
This spectacular spiral in the constellation Canes Venatici was first carefully observed by Lord Rosse and seen to be not merely a mass of glowing gas, but an aggregation of many stars.

It was by this method that Hubble determined the distance of the Great Nebula in Andromeda (Fig. 3) to be more than nine hundred thousand light-years. Another very large, bright spiral in the constellation of Triangulum was found by similar means to be at about the same distance. It is believed, however, that the thousands of fainter spirals are very much more distant. In Figs. 1 and 2 are shown two of the spirals in the region of the heavens designated by the constellation name Coma Berenices. Here, and in the adjacent region of Virgo, spiral nebulae are richly strewn on photographic plates of long exposure, and both Hubble and Shapley have estimated for some of these no less a distance than a hundred million light-years.

In spite of these tremendous distances much can be learned about the island galaxies, though, of course, the further away a galaxy is, the less up to date will be the news which the light brings. Thus, in the case of the Andromeda Nebula, approximately one million light-years distant, the rays of light which produced the image on the negative of Fig. 3 had been travelling through space for a million years, and consequently the picture we see is not Andromeda Nebula as it is to-day, but as it was one million years ago.

Just what it is like now we can only conjecture—probably not so very different from the picture, for one million years is less in the life of a star than one second of time in the average life of a man.

The radial velocities of the brighter nebulae can be determined by means of the spectroscope, and show that they are moving through space with great velocities. The Andromeda Nebula is approaching our galaxy with a velocity of 300 kilometres per second. Most of the spirals, however, are receding at speeds averaging 600 kilometres per second.

There are two ways of endeavouring to find out the total mass of a galaxy, and when two quite independent methods lead to results which are in good agreement the astronomer feels considerable confidence in the reliability of his calculations. The first method is based upon a speculation regarding the ratio of luminous to non-luminous matter in a galaxy and the theory that the luminosity is determined by the mass. When the absolute luminosity of a galaxy is known, its total mass can therefore be calculated. This method has been used by Opik, and gives for the Andromeda Nebula a mass nearly two thousand million times the mass of an average star like our sun. The second method depends upon the spectroscopic determination of the line of sight velocity of opposite edges of the nebula. If one side be found to be approaching and the other side receding, the only logical conclusion is that the whole nebula

is rotating. Now a rotating mass will fly asunder by centrifugal force unless some equal and opposite force hold its members together. If gravitation, acting towards the centre of the nebula, provide this balancing force, it is possible to calculate the total mass necessary to give rise to the restraining force required. The period of rotation of the Andromeda galaxy was found to be 17,000,000 years. From this its mass was calculated, giving just over three thousand million suns. The agreement with Opik's result is satisfactory.

Our picture of this best known island galaxy can be briefly summed up in a few words: A thousand million stars—like those in our own galaxy, some larger and some smaller than our sun—and much uncondensed gas, all forming the giant spiral nebula travelling through space at least 300 kilometres per second, and as it travels, slowing expanding and unwinding its spiral arms, while as a whole it is turning round with solemn, majestic deliberation.

The Einstein Universe.

Men of science throughout all the ages have been obsessed with the idea that there is order in the Universe.* When the great wave of agnosticism passed over Europe, threatening to sweep the thoughts of men from all moorings, this fundamental tenet of scientific faith was the sheet anchor which saved mankind. So deeply implanted is this belief in natural law and order, that when some facts of astronomy and physics appeared to be incompatible with the current conception of the Universe, based as it is on the stately geometry of Euclid and the Newtonian mechanics, men of science were willing to consider throwing over the old conception and adopting a new conception suggested by Einstein. This willingness is the more remarkable when it is remembered that, to the non-mathematical mind, the four-dimensional spacetime universe of Einstein seems mysterious, fantastic, and unreal. Yet there is already considerable evidence in its favour, and so, generalizing from his detailed study of 400 galaxies, Hubble proceeds to evaluate the radius, volume, and mass of the Einstein Universe.

He calculates first the average density of space. If the matter forming all the stars and gaseous nebulae in our galaxy and in the 400 other galaxies studied by him were to be spread evenly throughout the space occupied by these galaxies, there would be a density of matter equivalent to one atom of hydrogen in every 300 cubic feet. He then evaluates the radius of curvature of spacetime, which, according to Einstein, depends only upon this average density and two constants, the velocity of light and the gravitational constant. This radius comes out to be five thousand billion astronomical units (5×10^{15} times the sun-earth distance). This value is a thousand times greater than that calculated by Silberstein from other relations and other data available three years ago.† Here in reality, as always metaphorically, the horizon recedes as knowledge increases.

What then is the total amount of matter distributed as stars and as nebulae, in clusters and in galaxies, throughout this vast yet finite Universe? To express these figures in words is far too cumbersome, and so we set them forth in the elegant shorthand used always by the physicist and the astronomer—If M be the total mass of matter in the Einstein Universe, then

$$\begin{aligned} M &= 1.8 \times 10^{57} \text{ gms.} \\ &= 9.0 \times 10^{22} \text{ suns} \\ &= 3.5 \times 10^{15} \text{ normal galaxies.} \end{aligned}$$

In other words, there are about a thousand octillion (10^{51}) tons of matter, and were this to consist only of hydrogen there would be 10^{81} atoms.

How much real value these stupendous figures have, it is impossible to say. Firstly, they involve the Einstein conception of the Universe, not yet indisputably established. Secondly, they are conclusions regarding a Universe not one ten-millionth of whose volume can be explored by even the giant telescope at Mt. Wilson Observatory. If the distance of a galaxy exceed only one six-hundredth of the radius of curvature above mentioned, no telescope yet constructed can detect it. But a man will judge the world of humanity, their habits and characteristics, their comings and goings, by his knowledge of a few score individuals and his passing glimpses of a few thousand, and his conclusions will not be entirely valueless. So, too, the astronomer, with reliable knowledge of hundreds of stars and many nebulae, and glimpses of thousands yet more distant, will not refrain from speculation regarding the vast regions as yet beyond his ken—the ocean of space-time studded with a thousand billion glorious Island Galaxies.

REFERENCE.—The latest explanation advanced for "nebulium"—a problem to which the author refers on page 86—was dealt with last month in *Discovery* ("Among the Stars"). When passing through "metastable" states, atoms do not radiate light under ordinary conditions, but Dr. Bowen suggests that at the extraordinarily low nebular densities, collisions are extremely rare, and the metastable atoms get a chance for radiating light before their condition is changed by the collision.—ED.

* An interesting treatment of this subject may be found in "Science and the Modern World," by Dr. A. N. Whitehead.

† See "Measuring the Universe," *Discovery*, September, 1924.

People of the Great Plains.

By J. E. Pryde-Hughes, F.R.A.I.

Interesting sidelights on peasant life in Hungary to-day were obtained by the author during travels among peoples whose local traditions date back many centuries. The war has altered political boundaries, but the main racial factors remain unchanged.

BEFORE the war, when Hungary was a partner (if an unwilling one) of Austria, the frontiers of the country stretched along the Carpathians in the north, and the Adriatic in the south, and along the old Rumanian frontier, enclosing Transylvania, in the east, and Austria on the west. It was a remarkable geographical unit, the limits of the land being natural boundaries, and it enclosed not only the predominant race, the Magyars, but large and small pockets of other races, such as the Wurtemburgers, Rumanians, Slovaks, etc., and small nations like the Croats. These all preserved their customs and languages, and their religions, for Hungary—a definitely Roman Catholic country throughout—has always been tolerant in regard to religion.

Early Settlers.

Mingled with the people are descendants of the settlers encouraged by earlier monarchs, or left behind as the waves of Middle-Age invasions receded—Franks and Slavs, Walloon, Italians, a little Turkish blood in certain parts, and in the west the Kumans, pagans who settled in large numbers after the Mongol invasions, at a time when Hungary stood as the stalwart of western culture and religion on its eastern frontiers.

To-day Hungary, a free nation, is very much reduced, and her frontiers are economically and gecgraphically unsound. In my trampings recently, I had not far to go before factors presented themselves to prove this. However, as nations go in Europe in our times, the present frontiers enclose a comparatively pure race, predominantly Magyar.

It is well over a thousand years ago that the Magyars poured over the Carpathians and into the Great Hungarian plain. Here they fought and disposed of the inhabitants, a mixed race of Bulgar and Slav, Hun and Avar, and finding an elementary civilization, finally settled down to develop it. Prior to the Magyar invasion there had been various occupations of the land; following the Bronze period we learn of Germanic Marconians and Quadans in the North-western Highlands, Gaeto-Dacians, whose origins we do not know, and who were absorbed by the Romans, in the Transylvanian basin, then Goths, Vandals, and Gepidae and the mixed Sarmatians.

It was in the fifth century of the Christian era that the first of the Central Asiatics on their westward migration, the Huns, under their great chieftain Attila, swarmed over Hungary, and from an encampment between the rivers Tisza and Danube prepared for the "conquest of the world." How far Attila progressed we know from the history of our neighbours. But Attila's dream was unaccomplished when he died, and the Huns, losing heart, for the most part returned to Asia. Their westerly path was followed some years later by a kindred folk, the Avars (who have left many traces of their occupation in the soil of the Great Plain). They enjoyed possession of the land for about two hundred years, during which time they were attacked by Franks on the west, who took Esztergom, the old *Salva Mansio* of the Romans, and renamed it Osterringun. Esztergom is now the home of the Primate of Hungary, and centre of the Roman Catholic religion of the country. Southern and western Slavs also filtered in and a peaceful period of development reigned till the arrival of the Magyars.

A Disputed Origin.

The Asiatic origin of the Magyars is still a subject of argument. It would seem that they belong to the Ugrian peoples settled in the broad territory between the rivers Ob and Irtish in Western Siberia. The westerly migrations of these peoples commenced long before the advent of the Magyars in Europe, the earlier movement being through northern Russia, and proceeded as far as the Baltic coast, Finland and Lapland; the Lapps perhaps were pressed up into their inhospitable Arctic Circle settlements by the fighting folk of the more fertile lands. Pockets were left in Russia, but as in the case of the Samoyed, these were frequently pressed northwards into even less happy climes than those from which they had set out. Fighting, and pressure from more easterly warlike tribes undoubtedly caused these eruptions into Europe, as in the case of the Magyars who first paused in the Urals after leaving the mother country, proceeded to the Volga and came to rest in those territories

now known as the Bessarabia, Moldavia and Bukovina. They were now joined by Turkish folk, but of the seven tribes which banded together under Almos, the head of the Magyar tribe which gave its name to the people when they moved on again, the bulk were Ugrians. A small, neatly built and wiry people, with chestnut hair and grey eyes, they were fine horsemen and great fighters, yet they were tractable and accepted the leadership of the Turkish clan, dark-haired men speaking a different tongue. When they descended on to the Hungarian Plain, led by Arpad, who founded the first dynasty, the Ugrian element, finding the conditions similar to those of their late home, continued to live the life of their ancestors, fishing, hunting and tending cattle, and to-day the terms used in connection with these pursuits are of Finno-Ugrian origin, while the agricultural terms are Turco-Tatar. The Magyars are a round-headed brachycephalic people, and have a very lively sense of race, which has helped them through many difficulties.

THE "CLEAN-ROOM" IN A HUNGARIAN FARMHOUSE.
The peasants reserve this room for guests, and on the bedstead the family embroidered linen is seen piled to the ceiling. The "clean-room" is probably of religious origin.

Perhaps the above outline, though superficial, will give some idea of the people of the Hungarian Plain who, while preserving their habits and customs, language (despite attempts to repress it and the almost general use of Latin at one time), and ways of living, have shed all outward signs of Asiatic origin as commonly held. True, one will find chestnut hair and grey eyes, and on the Puszta short, wiry men, with tanned skin and quaint ancient ways of regulating life, but through this one cannot distinguish anything but an intelligent people clinging to traditions which are a part of their very being. Myths and stories, too, go back to the steppes, and the troubles with Bulgar and Pecheneg, but little further. Love of the hunt and the horse is as strong in Hungary to-day as a thousand years ago, when the dashing Magyar horsemen ranged as far as Burgundy in the west, Otranto in Italy, and carried their forays under the very walls of Constantinople. From these wild horsemen we get the light cavalry called Hussars, and in all likelihood it was the Magyar who made the stirrup known to the Aryan peoples of Europe. In their love of hunting and horses the Hungarian exhibits characteristics which have their counterparts in Great Britain, and it is perhaps natural that the people look towards England with the greatest friendship and desire for intercourse. Many British institutions have been introduced into Hungary, chiefly by that fine man Count Stephen Szechenyi, and Hungarians will never forget the welcome given here to the liberty-orator, Louis Kossuth. In the history of the land one also finds many parallels with incidents in British economic and social developments, one in particular being worth mention.

In 1222, that is seven years only after King John was forced to put his hand to Magna Charta at Runnymede, King Andrew III, at Szekesfehervar, issued the Golden Bull, which similarly put a restraint on the Royal prerogative and set the seal on the constitution of the country.

The clan system is still preserved in Hungary, the old clans being built up from the great families whose heads were leaders when the hordes of Arpad took possession of the Plains. But besides the tribal clans of the Magyars there are those pockets of other blood already referred to, and in the preservation of racial characteristics these have formed other clans; thus we have the Swabians, and the Sokacs, the latter a Serbo-Croat people settled in the south, principally near Pecs, whose ancestors were driven out of Bosnia before the Turks during one of the periodic invasions of Central Europe, and found refuge and comparative sanctuary on the lower Hungarian plains. Most interesting of these "clans" is the Matyok of Mesökovesd, at the foot of the Matra mountains. A Kun-Tatar people, they take their clan name from King Matyas (or Mathias) who favoured them. They are an extremely artistic people, of a few thousands all told, and they only very rarely marry outside the clan; the schoolmaster of the village told me that within his recollection not a single case had occurred of a Matyo

marrying an outsider. And yet they are a fine race, both men and women, intelligent and well set up. The men sometimes attain to 6 ft. 6 ins., and 6 ft. is comparatively common—in great distinction to the true Magyar who is short, inclined frequently to stockiness, though always lithe. The Matyo, like the pure Magyar, is rather slender and lissome. The moral standard is a high one, and should there be a falling away from the standard on the part of a young couple, I was told that the young man is the one to be ostracised by the clan, and not the girl, though a girl who has erred looks forward to unmarried life. This is in itself punishment enough among a people who regard marriage as the pivot of all things. The young fellow looks forward to the wedding day as a stepping-stone to manhood. He then attains manhood, and can enter the councils of the elders; until then he must do the work of a boy, which to these early maturing folk is abhorent. Marriage, therefore, a matter of arrangement between two families and lacking the preliminary country-lane courtship of more westerly peoples, is decided on at an early age.

The Matyok are especially noted for their splendid embroideries. All over Hungary the womenfolk weave linen and embroider it during the dark winter months when they cannot work in the fields, but in and about the tiny township of Mesökovesd the men too ply the needle, and, indeed, the finest designed and worked Matyo embroideries are done by the men. There are about eight or nine main motives incorporating the Magyar tulip as a base, and with these hundreds of different designs are worked out in ever-varying combinations of colours according to the instinct and taste of the worker. The motives are probably many hundreds of years old, and it is extraordinary how purely they persist; but the Matyok have no guide-books; the art is handed down traditionally, and the peasants work mainly by instinct. I would attribute much to developed instinct, for I have seen an old woman designing with a yellow crayon on a piece of black canvas material with tremendous speed, freehand, but unfailingly working to the desired end; and repeating the performance from the same centre time and again without copying any of the other designs. This old lady told me she had not the faintest idea when she started what the result would be, and yet she unerringly finished her design without once having to delete a line or go back to alter or add a stroke.

A PEASANT WEDDING

Bride and bridegroom of the Bessenyös clan from the south Balaton district. The embroidery of the groom's great sleeveless coat is sometimes the work of the man himself. This garment and the petticoat trousers are worn by all Magyar peasantry.

While some of this embroidery is used for house-interior decoration, most of it is for the embellishment of dresses, in the case of the men for the bottoms of the black aprons they wear and the full sleeves of their light blue blouses. The girls have shawls and other wearing apparel so decorated; their skirts are flounced and sway like concertinas, while the blouse sleeves are ruffled. Unmarried girls braid their hair, but the young married women wear silk handkerchiefs hung over a stick about a foot long, which is fastened on to the hair on the top of the head with a pad. Often a girl will, on festive occasions, wear dresses and embellishments worth anything up to two hundred pounds. With the Matyok, as with Magyar clans, garments are the outward signs of the peasant's wealth, and even in the hot summer Magyar girls will wear as many as ten, twelve, and perhaps fifteen petticoats, which billow out as they walk giving them the appearance of quaint Dresden figures come to life. These dresses are probably heirlooms to some extent, for the clothes, together with the linen and embroidered material kept in the "clean-room," and the painted plates on the kitchen walls, go to form the dowries when the girls marry. The "clean-room," by the way, is significant. Each "Tanya," or sundried mud-brick farmhouse, has a parlour which is reserved for guests. In this room there are frequently a couple of wooden bedsteads piled to the ceiling with linen, sometimes beautifully embroidered, also a chest of drawers, and the "tulip"

chest, a large painted clothes box with the tulip design painted on it. The beds are not to be slept in. Only on rare occasions to honour an important guest will they be used; indeed, they are reserved for the "honoured guest," and though the peasant will not be able to tell one who this may be, I feel that the reservation of these beds arises from early religious traditions, and is for the re-appearance of the "Christ." I have found something similar in other out-of-the-way places in Europe, and even in Wales, though in modern times I think that there it has more to do with the possibility of accident and sudden death in quarry and mine.

Turning for a moment to archaeology in Hungary, the recent finds at Pitvaros may teach us a deal about the earlier life of the plains. While cutting a road in the light soil between Pitvaros and Ambrozfalu, workmen unearthed a number of graves, apparently of early Bronze period. I happened to be in the neighbourhood, and the notary of the village took me to see the graves and their contents. All the material is now being carefully studied at the museum at Szeged. It is to be hoped that the result will soon be published to the world, and that new light will be shed on the pre-history of this part of the great river basin, which some regard as the birthplace of European civilization.

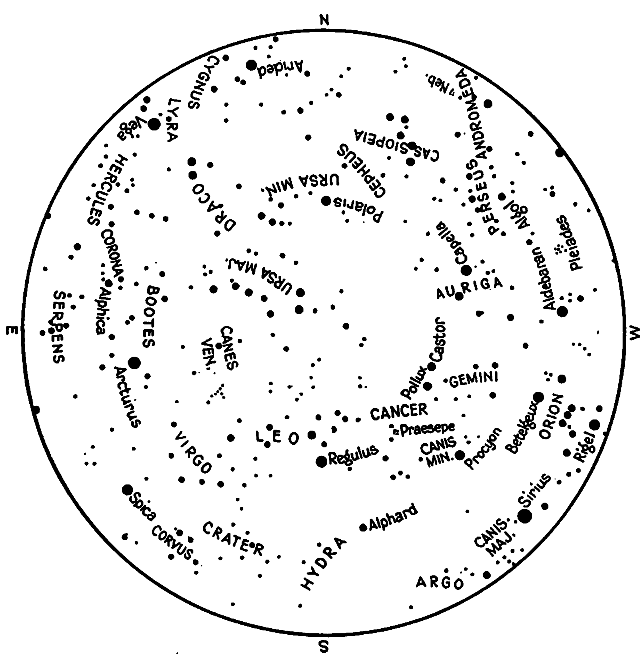
It was in mid-Hungary, on the Hortobagy Puszta, that wide uncultivated moor given over to the huge wide-horned cattle (descendants of those cattle which dragged the rude wagons of the migrating Magyars) and the troops of untamed horses, that I found the greatest personal interest. Of this strange territory, where the primitive life has altered but slightly since the days of Arpad, I hope to give some account in a subsequent article.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

THE FACE OF THE SKY FOR MARCH.

We have reached the month of the vernal equinox; the map shows Regulus on the meridian, and Orion "sloping slowly to the west." Virgo, Bootes, and Lyra are coming into view. The "Pointers" in Ursa Major are nearly overhead. The only planet within the limits of the map is Neptune, which is $1\frac{1}{2}°$ west and 40′ north of Regulus. Saturn may, however, be observed in the south-east at a later hour of the night.



The Face of the Sky as seen from London at 10 h. sidereal time; on 7th March at 11 h. p.m., on 22nd March at 10 h. p.m.

New Study of the Sun.

Half a century ago Richard A. Proctor was famous as an astronomical lecturer and writer, having a notable gift for expressing difficult conceptions in attractive and intelligible language. His books may still be read with profit by astronomical students, but, of course, the great increase in astronomical knowledge since they were written renders them somewhat out of date. His daughter, Miss Mary Proctor, is carrying on the family tradition, and is engaged on a series of popular works on the Romance of Astronomy, of which *The Romance of the Sun* (Harper and Brothers. 7*s.* 6*d.*)., is the latest instalment. The introduction sketches the advance in knowledge of the sun from the earliest times; the following chapters deal with the difficult problem of the sun's distance; the various transits of Venus, the expedition of the Gills to Ascension, in 1877, for observing Mars, and the Eros campaign in 1900, 1901, are described in an interesting manner, with many human touches. Then we have the exposition of solar physics, our knowledge of which has been enormously advanced by the spectroheliograph, independently devised by Hale and Deslandres. There are excellent reproductions in the book of photographs both of the sun's disc and of the chromosphere taken with this instrument. Then follows the story of the corona and of total eclipses of the sun. The author has herself taken part in a number of eclipse expeditions, and narrates her experiences very vividly. In particular, she observed the British totality of June, 1927, from an aeroplane; there are so few records as yet in astronomical annals of eclipses observed in that manner that this section is particularly interesting.

Two small slips should be corrected: P. 184, read 4.58 for 2.58; p. 195, Mr. Shackleton observed the eclipse of August, 1896, from Nova Zembla, not from Vadso.

Researches on Winding Rivers.

By F. J. North, D.Sc., F.G.S.

Geological Department, National Museum of Wales.

Meandering streams are a favourite subject for poets. As a rule, however, their work suggests that in common with most of us they are not familiar with the cause of these occurrences. The unusual photographs the author has obtained show very clearly examples of deserted river beds in a valley floor.

The descent to sea-level from its source in the mountains imparts to a stream a certain amount of energy. which is expended in developing a valley. Near its source a stream usually runs down steep declivities, and the water moves rapidly. Swiftly flowing water has considerable power of transportation, and it carries along mud, sand, and sometimes pebbles, by means of which it wears away the rocks over which it flows, thus tending to make a steep-sided valley, the cross section of which resembles a letter V, with the river flowing at the bottom.

As the stream bed is worn down nearer to sea-level, the rate of descent diminishes, and the water moves more and more slowly; its transporting power is reduced, and some of its load is dropped; its power to wear away its bed is considerably curtailed, and the stream is easily deflected from its course.

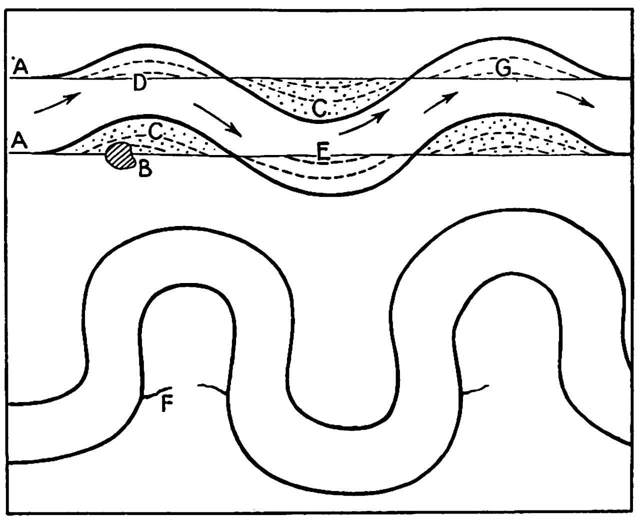


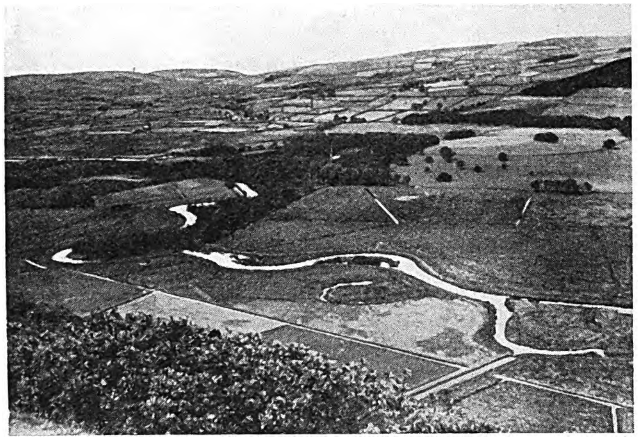
Fig. 1.
HOW MEANDERS DEVELOP.
Owing to a deflection in the current, one bank of a river is worn away and a sandbank is formed on the opposite shore. Details are given in the text, which also describes the development of tributaries shown in the lower part of the diagram.

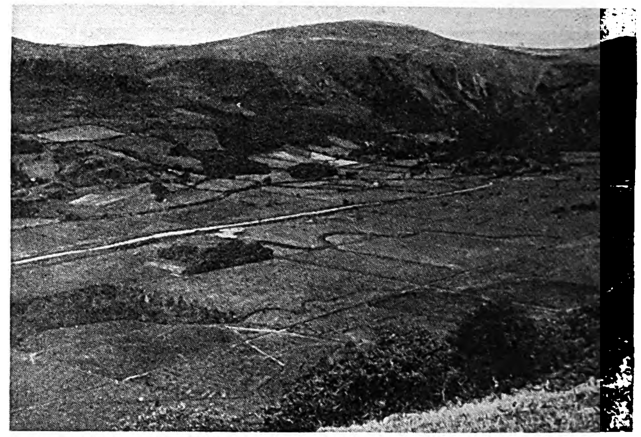
Differences in the hardness of the material forming the banks, or comparatively small obstructions, are sufficient to cause a slow-moving stream to cross its direct course, deflecting the current towards one bank, which is, in consequence, worn away. At the same time the velocity on the side where the obstruction occurred is checked, and some of the solid material which the water holds in suspension tends to be dropped there, so that once a curve has been initiated it tends to increase its sweep as material is moved from one bank and is deposited on the other.

In the diagram (Fig. 1) the lines AA are intended to represent the banks of a stream following a straight course, B is an obstruction which deflects the current, and C is the beach-like accumulation of sediment formed on the bank opposite to that which is being worn away. Immediately a concavity is formed in one bank (D), the current is directed towards the opposite bank (E) and from thence to G, with the result that if a curve develops at one spot, the tendency to become sinuous is transmitted down the stream, and the development of curves or meanders may continue until the distance between two points in the river's course may be only a small fraction of the length of the channel separating them. As a result, if travelling in a boat, one appears, over and over again, to be approaching a spot that was passed some time before, or if travelling by train one crosses and re-crosses a stream, as is the case near Bedford where the railway crosses the Ouse seven times in as many miles. Hereford and Ross are only about eleven miles apart, but between the two towns the water of the Wye travels twenty-six miles and flows in turn towards every point of the compass.

The curves are called meanders, and the habit, meandering, after the name of a river in Asia Minor which follows a particularly sinuous course. When the stage indicated in the upper diagram in Fig. 1 has been reached, small tributaries may develop (F), still further reducing the barriers which keep the water in its course, and there will be a tendency, especially during floods, for the water to break through the narrow necks of land, thus taking a more direct course.

Since in passing round the bend the stream travels a considerable distance, there will be a difference of level between the ends of the new direct channel,





FIGS. 2 AND 3.
TWO VIEWS OF THE DYSYNNI RIVER, NEAR TOWYN, NORTH WALES, SHOWING OX-BOW LAKES AND DESERTED STREAM COURSES.
These photographs were taken from almost the same spot, that on the left, looking down-stream, and the other looking up-stream. An ox-bow lake is seen in Fig 2, as a crescent-shaped depression cut off from the main stream, while near the present straight channel in Fig. 3 are two deserted stream courses.

and the rate of flow will be, for a time, accelerated. The increased energy is accompanied by greater transporting power, and the new channel is rapidly increased in size until it takes the whole flow. In this way the old curves are deserted; their ends become blocked by accumulations of sand or mud, and they give rise to crescent-shaped lakes. These in time become swampy patches, which, by the growth of vegetation and the accumulation of sediments carried by the wind and rain, are gradually converted into parts of the general meadowland, to be distinguished only as slight depressions in the surface, or by differences in the colour of the vegetation. In many cases such deserted meanders cannot be detected by an observer on the ground, but they are clearly visible from a height.

The Dysynni River, which flows from Talyllyn Lake in North Wales and enters the sea near Towyn affords an excellent opportunity for studying the development of meanders, and the valley floor retains traces of deserted stream channels much more distinct than is usually the case.

The accompanying photographs (Figs. 2 and 3), were taken from an elevation of about 800 feet on the side of Foel Wyllt, which forms the south-eastern side of the valley about four miles from its mouth. They were taken from almost the same spot, one looking down-stream and the other looking up-stream. On the left hand side of Fig. 2 the river is seen to swing in great curves around the parkland and woods of Peniarth, whilst on the right hand side are two deserted curves. One is still connected with the main stream, but the other has been entirely cut off by the deposition of sediment, and is represented by a crescent-shaped depression containing a small lake; by deserting these two curves the river has shortened its course considerably.

In Fig. 3 the river follows a straight course for about a mile, but its former sinuous course across the plain is indicated by slight depressions, rendered conspicuous by differences in the appearance of the vegetation. The junction between the present course and the old one is marked by a small lake, separated from the main stream by a narrow barrier. A still older deserted course is seen in the foreground.

The River Towy, a few miles before it reaches Carmarthen, affords excellent examples of the crescent-shaped lakes so characteristic of a meandering river that frequently changes its course. Some of the deserted channels are still connected, at one end, with the main stream, whilst others have been silted up at both ends and are completely isolated (see Fig. 4): by the Americans such lakes are called "ox-bow" lakes. Meanders are particularly well-developed along the Mississippi; for instance, some distance north-west of New Orleans the river makes a circuit of twenty-six miles and returns to a point less than a mile from where the curve commenced.

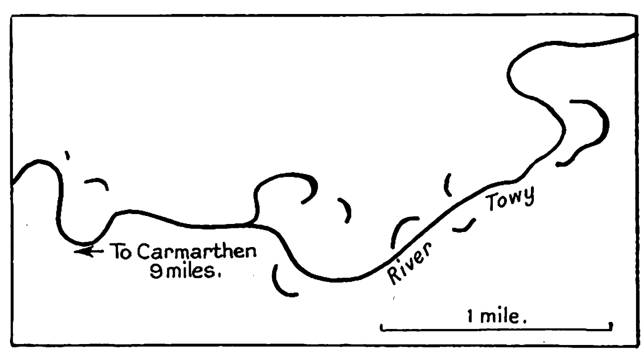


FIG. 4.
MEANDERS AND OX-BOW LAKES NEAR CARMARTHEN

As a stream moves to and fro across its valley in the course of its meandering, the sand and mud it has brought down from the hills is shifted and re-deposited over and over again, and, being enriched by the remains of vegetation which decayed upon its surface, it will, if adequately drained, provide very fertile soil. In many cases the floor of such a valley is highly cultivated, while the hills that rise abruptly on either side are clothed only with their natural vegetation.

When Robert Montgomery wrote :—

> " The soul, aspiring, pants its source to mount,
> As streams meander level with their fount."

he was severely criticized by Lord Macaulay, who described the couplet as the worst similitude in the world ; but although it is perfectly obvious that having once started on its way to the sea, a river can never again run level with the spring that gave it birth, it is at the same time a matter of common knowledge that the phenomenon of meandering is best displayed when a river flows in a broad valley over a surface that, as far as the eye can judge, is almost flat.

FIG. 5.
THE DYSYNNI RIVER APPROACHING THE SEA.
Meanders are most frequently formed as a stream approaches the sea, when the gradient of its bed and its velocity are least.

Local conditions may give rise to broad, gently sloping valley floors in various parts of a river's course, but meanders are most frequently developed when a stream approaches the sea (Fig. 5), because it is there that the gradient of its bed and the velocity of its water are least.

Correspondence.

AMUNDSEN'S AUTOBIOGRAPHY.

To the Editor of DISCOVERY.

SIR,

The passages concerning Stefansson in Roald Amundsen's " My Life as an Explorer," commented upon in your January issue, are not nearly so surprising as others concerning Scott in the same volume.

Stressing the advantages of a base-camp placed, as his was, on the Ross Barrier, Amundsen writes : " . . . Scott's choice of a site (for his base-camp) on the mainland to the west was an essential factor in his inability to return in safety from the Pole." Scott's base was on Ross Island, at least forty miles from the mainland. The writer maintains that the adverse weather conditions encountered by Scott were due to the proximity of his base and route to the mainland, but seems to overlook the fact that his own base at the Bay of Whales was not very far from King Edward VII Land, and that he also had to cross the mountains and traverse the plateau, in either of which regions, according to his contention, he might well have encountered bad weather.

Amundsen, writing that " Scott and his companions died . . . from actual starvation, because of their inability to provide adequately for food on the return journey," cannot have read these passages in Scott's " Message to the Public " : " Every detail of food supplies, clothing and depots . . . worked out to perfection. We arrived within eleven miles of One Ton Camp with fuel for one last meal and food for two days "—in spite of the serious delays caused by the illness and loss of Edgar Evans, and later by the incapacitation of Captain Oates.

Any person unfamiliar with the history of Scott's last expedition, and with the causes contributing to the disaster, could not but infer from Amundsen's words that the latter was due to faulty planning. He draws an unfair contrast, and writes in another chapter : " Our success in attaining the Pole was due to the correctness of our planning." One cannot read Amundsen's " The South Pole " without admiring the constant thoroughness and scrupulous attention to detail, both at the base and on the journey, but what seems far more evident was his wonderful luck, in weather conditions, snow surface, and freedom from serious accidents and ill-health. The route he chose was quite unknown (Scott followed in his own and Shackleton's tracks as far as 88° latitude), and he might well have reached the mountains at an impassable point.

Yours, etc.,

Belfast, *6th February*. FRANK PIGOT.

PAGAN FESTIVALS IN MODERN EUROPE.

To the Editor of DISCOVERY.

SIR,

There are many common festivals held all over Europe and in our own isles which are of pagan origin. In my wanderings on the continent I have met with a number of these festivals, especially in the spring : the *Fasching* processions usual in Austria and Germany are, of course, relics of pagan worship, particularly in regard to Scandinavian and Germanic deities ; perhaps, indeed, like the many spring festivals they go back even farther. Ignoring Yuletide and the Maypole, we have relics in Staffordshire, in the Shetlands, and parts of Scotland, of pre-Christian worship in present day local festivals, many of which have been carefully dealt with in various publications. The subject is fascinating, and I should very much like to hear more of actual local customs of this nature, on the continent especially. Perhaps readers of *Discovery* have occasionally had experience of such festivities, and would send me particulars addressed in your care.

Yours faithfully,

London, *21st February*. J. E. PRYDE-HUGHES.

Book Reviews.

The Ant People. By Dr. Hanns Heinz Ewers. Translated by C. H. Levy. (John Lane. 8*s*. 6*d*.).

The popularizing of biological science is of the utmost importance from the point of view of making governments and charitably disposed individuals supply the money necessary for the carrying out of research work, and yet we find that the scientific man who undertakes such work is rather looked down upon by his colleagues. Consequently, a number of popular biology books are written by people who have little or no scientific knowledge, and who therefore either give an account, frequently inaccurate, of the work done by others or who draw erroneous conclusions from things they have themselves observed.

The author of this book is a writer and a poet who has travelled in many parts of the world, and who has taken an unscientific interest in ants. He scorns " scientists," whom he describes as " pedants " (p. 108,) and says they "must not take it ill in us artists if we, on our side, take what the scientists tell us for what it is—stupid work, in which the gift of the artist to conceive something intuitively (some rare cases excepted) is altogether lacking " (p. 103).

I cannot but feel that there is a great deal of intuitive conception in the book, perhaps due to the fact that the author has " tried . . . to attain the soul state of the ant, as a poet may do perhaps better than a scientist " (p. 51). But if one accepts the book from this point of view, it will be found quite interesting, some parts, for instance, the description of the invasion of the author's house by wandering ants (*Eciton*) (pp. 78-85), being really good.

The extraordinary names given to different species of ants, *e.g.*, speckled stinging ants, narrow-breasted ants, Pharoah ants, etc., are fortunately explained in an appendix, although I only discovered this by accident, as there is no reference to it in the body of the book. The translation is not up to the style of the late Count Teixeira de Mattos or Alfred Sutro and, at times, the English is weak and the spelling American.

Frank Balfour-Browne.

History of Science Teaching in England. By D. M. Turner. (Chapman & Hall. 7*s*. 6*d*.).

Miss Turner, who was head of the science department at Wycombe Abbey School, has given us in compact form a most useful contribution to the science teacher's library. It is highly desirable that all who are engaged in science teaching should know something of its history, yet very often they know nothing. It is desirable for several reasons. Such knowledge will give them an explanation of the situation in which they find themselves in the educational system, it will show them the influences that have prevailed, the mistakes that have been made, and it will save them from being deceived by the proclamation of old doctrines as new gospel.

The book consists of ten chapters, the first four giving a very interesting and succinct account of the chief influences affecting natural science and the teaching of science from the time of Roger Bacon to the beginning of the nineteenth century. After this the history becomes more detailed, an account being given of the development of science teaching in the universities and other institutions for higher education. The outcome of Royal Commissions and State enactments is clearly set forth, and reference is made to the doctrines of the more modern prophets who have from time to time propounded what they conceived to be the true faith. To the accuracy of Miss Turner's history of science teaching in the last half-century the reviewer can, with mixed feelings, bear unhesitating witness : in its detail and its general trend it accords exactly with his own recollections. Miss Turner from her studies and experience has, of course, acquired opinions of her own upon the subject of science teaching, but where she turns from history to comment she is eminently fair. It is pleasant to be able to say amidst the present redundancy of new books for the science teacher that here is one which was really needed.

A. Smithells.

Animal Parasitology : An Introduction. By C. L. Walton and W. Rees Wright. (Sidgwick & Jackson Ltd. 6*s*.).

One of the central ideas in biology is that of the linkage of lives. It is an old idea this correlation of organisms, but it is the central idea of the new biology. Nothing lives or dies to itself ; everything, as John Locke observed, is a retainer to some other part of Nature. It is common knowledge that widely separated forms of life are often linked together by being the two hosts of one parasite, of which we have an example in the sheep and the little water snail being the two hosts of the liver-fluke, which is the cause of very serious losses to farmers in many districts. Our authors give an interesting account of this parasite and the host snail, describing the latter also as " a serious potential danger, to be treated as such," but they do not tell us of the great service to human life which a study of these very relationships rendered. From a knowledge of this three-fold association, Dr. Leiper was able, during the Great War, to prove that a parasite inimical to human life called Bilharzia, and common in Egypt, spent its early stage inside a species of fresh-water snail. The microscopic larvae pass from the host into the water, and thence into the human body, entering through cracks and chafes in the skin. It is claimed that, by showing that the undesirable aliens can be kept back by good filters, and that the free-swimming stages die within thirty-six hours in water that is kept stagnant, Dr. Leiper's discovery has saved thousands of lives. The whole life-cycle of some parasites is thoroughly understood. Such knowledge is of the utmost importance, and may be of the greatest practical value. It is, too, of importance to realize that in many cases after a parasite has gained access to the host we may be helpless in expelling it, whereas removal of some of the conditions essential to its development outside the host may be practicable. Prevention is not only better but easier than cure.

The essential merit of " Agricultural Parasitology " is that it fills in the gap in the literature of the subject between the elaborate works largely of a technical character, but only partly informative, and the specialist writings, while at the same time it combines biological principles and practical application in a concise form. Its contents are restricted to the more important parasites of farm live stock in the British Isles, anything outside being included for the purpose of giving perspective or force to an argument. The liberal bibliography provided to each of the twelve chapters enhances its value to the student. The opinion may safely be expressed that the book is likely to prove a useful and important one, provided that it can secure the attention of the class to whom it appeals. As it is a work of more than academic interest, the working farmer should be grateful for this contribution towards the solution of one, at least, of the problems that menace his well-being.

H. H. W.

Social Life in the Animal World. By FR. ALVERDES. Translated by K. C. CREASY. (Kegan Paul. 10*s.* 6*d.*).

A most interesting book, based largely upon the observations of others, and one important point which one learns from reading it is the extraordinary difficulty one has in obtaining accurate and definite statements as to the habits of animals. The author classifies certain habits under headings, such as "seasonal mateships within the herd" and, after giving a number of would-be examples, he says, "In all these cases it is not certain whether we should speak of seasonal or permanent mateship." It is quite certain that many would dispute his classification in many cases.

On p. 22, under "Social instincts in solitary animals," reference is made to hibernating societies, though the author admits that it is uncertain whether there is any social instinct concerned. One gets, at times, the feeling that theoretical statements are made very positively, while what are supposed to be facts as to the habits of animals are stated without much conviction.

Up to p. 82, one has got used to the method on which the book is based, general headings with what are believed to be examples. From p. 83 to p. 106 we have a chapter on special animal sociology in which the habits of the best known social insects are described at length—an entirely different method. No conclusions are drawn, and there is no attempt to classify the habits or to discuss the origin of the social life. Following this, we return to general headings, the method adopted in the earlier chapters.

In some places the author brings forward theories, sometimes interesting ones, for instance, the "pecking order" in fowls (p. 125). In other places, as in the section on courtship and dancing (pp. 144-151), he deals merely with facts without referring to the fascinating theories on the subject.

The last chapter in the book, on "Human Sociology from a Biological Standpoint," covers only nine pages, and is rather disappointing as a summary of all that has gone before. "Tradition among men has above all this advantage over tradition among animals, namely, that it has a cumulative effect. . . ." (p. 201). Surely something might have been said here on the theory of "race memory" as accounting for the instincts of social insects?

However, it is very easy to pick holes in other people's work, especially when that work covers such a vast amount of ground.

FRANK BALFOUR-BROWNE.

Living Machinery. By A. V. HILL, M.A., Sc.D. (G. Bell & Sons. 7*s.* 6*d.*).

The younger generation is becoming wiser every day in the ways of machinery and, although good-naturedly tolerant, slightly superior towards anyone who betrays an ignorance of the anatomy of a carburettor or hesitates in distinguishing between the high and low tension system of a wireless set; yet, as a rule, boys and girls do not know much more about the machine in which they live than William the Conqueror did, and although they may be experts in geography, they are often very ignorant of what Sir Thomas Browne called "the Cosmographie of My Selfe." For this ignorance there is at least one very good reason, for the human machine is not one in which "the whole engine is exposed to view on removing the bonnet," nor are "all parts instantly detachable," but it is a machine whose working can be studied only indirectly and by means of elaborate and delicate apparatus. The amateur is therefore compelled, if he would learn about the human body, to make acquaintance with it at second hand, and this relationship with the subject is liable to be both dull and uninviting. Professor Hill removed this obstacle in the approach to physiology when he gave his Christmas lectures at the Royal Institution, by bringing with him his apparatus of investigation and revealing the workings of the machine under the eyes of his audience. With an X-ray installation he showed them the living heart as a shadow pulsating on a fluorescent screen, he broadcast the sound of its beating through a loud-speaker, and measured for them the electricity which it generates at each beat.

The lectures are here reproduced in book form, and give a fascinating account of the human engine; its efficiency is compared (quite favourably) with that of the artificial engines, and its "performance" is investigated on the cinder track and in the laboratory. But, although Professor Hill is especially interested in the human body as an engine which converts chemical energy into work, he shows it to us in its larger aspect as a co-ordinated machine, and devotes the first chapter of his book to the message carried by the nerves, that still mysterious impulse about which we seem to know everything except what it is. In a later chapter he gives a simple account of the complicated methods by which the interplay of our muscles is directed and controlled.

The story loses a little vividness in translation from the spoken to the written word, but the book is full of excellent illustrations—from Leonardo da Vinci to instantaneous photographs of high jumpers and diagrams of the latest intricacy for measuring the speed of the nerve impulse—which largely compensate for the loss of the rather diverting excitement of the actual demonstration. The book will be of greatest interest to those who attended the original lectures, enabling them to work out the details of the phenomena which were then presented to them in all the wonder of their unfamiliarity, but it will be also a stimulating introduction to the study of the human body for anyone whose interest in mechanics is not limited to things of metal.

F. A. H.

The Great Physicists. By IVOR B. HART. (Methuen. 3*s.* 6*d.*).

In this book the writer has attempted a great task, and his attack is very resolute. It is a review of historical physics and the work of famous physicists from the tentative philosophy of classical antiquity to the achievements of experimental and theoretical science of the last century. In writing such books, there must be an overwhelming temptation to allow the serious purpose of the book to be ousted by the insertion of amusing, valueless anecdotes of the mannerisms of the great physicists. The author has resisted such temptation, and his book may be regarded as a serious contribution to historical science. It will not appeal to the full-time physicist, whose training is not complete without a knowledge of the historical aspect of the science. But the earnest amateur, who treats science, not as a life-work, but as an absorbing hobby, will enjoy the book. The author has a knack of making dull elementary theory interesting—the knack, we think, is the administration of small doses at a time. The average reader of scientific books expects his reading matter to be like a good play—provocative ideas, interspersed with amusing relief. "The Great Physicists" fulfils these demands. One would have been more satisfied, perhaps, if the author had gone a little further, and indicated the gigantic bounds of progress made within the last decade. Possibly he holds the historian's view that history cannot be reviewed until it is a hundred years old.

J. F. L.

The Principles of Petrology: An Introduction to the Science of Rocks. By G. W. TYRRELL, Ph.D. (Methuen & Co. 10*s*.).

At the present time the mere mention of the word "evolution" tends at once to rivet the attention of the reader. It is a subject in which everyone is deeply interested, whether from the religious or the purely scientific standpoint, and Sir Arthur Keith's recent address to the British Association at Leeds showed that its discussion is still very much alive. Few of us, however, are familiar with the idea of evolution amongst the rock masses which form this globe. Dr. Tyrrell has laid special emphasis on this viewpoint of his subject, and the genetic principle is well to the fore throughout the book, which is the first of a series of geological works to be published under the general editorship of Prof. J. W. Gregory, F.R.S. With such a brilliant and useful beginning we look forward with interest to the remaining volumes.

The present instalment is the type of book specially suitable for readers of *Discovery*. It gives a clear and concise account of the present position of the science and rather aims at the explanation of general principles than the description of a multiplicity of illustrative examples. On the other hand, sufficient examples are introduced to explain fully this genetic standpoint, and the geologist will note with joy that Dr. Tyrrell has unearthed some new and refreshing references instead of using the hackneyed illustrations which appear with monotonous regularity in most textbooks.

From the standpoint of the advanced geologist Dr. Tyrrell is certainly at his best in the last section of the book, which is devoted to the exposition of metamorphic rocks. These are members of either the primary or secondary classes, which have been changed or metamorphosed by the action of great heat or pressure, thus producing new structures and minerals.

Not the least useful feature is the numerous footnote references to original sources of information, many of them of the type not usually found in a geologist's "stock-in-trade." We have noted a few errors in these, but such are inseparable from first editions and can be remedied in the future, for we have no doubt that Tyrrell's Petrology will soon be found on the bookshelves of all working geologists. F. S. W.

The Aerial A.B.C. and Commercial Air Line Gazetteer. (Aerial A.B.C. Ltd. 1*s*.).

In the early days of aviation, if anyone had prophesied the mere possibility of air liners flying to schedule all over the world, the notion would have been received with derision. But just as the first slender "Bradshaw" was the pioneer of modern railway guides, so world aviation now has its publication issued under the title above.

Time-tables, fares, freightage, rates, distances, air ports, aerodromes, and linked motor services are all classified in this compendium of flying, while there is also a list of agencies and receiving depots for goods, air-post rates, passport information, and everything that the potential "user of the air" requires to know. One of the most useful features is the clear maps with which this guide is illustrated, which in these early days of commercial aviation it is no small feat to have compiled.

Books Received.

Everyday Electricity. By JOSEPH R. LUNT. (The Macmillan Company. 7*s*.).

A System of Qualitative Analysis for the Rare Elements. By ARTHUR A. NOYES and WM. C. BRAY. (The Macmillan Company. 21*s*.).

A Study in Tubercle Virus, Polymorphism, and the Treatment of Tuberculosis and Lupus with Oleum Allii. By WILLIAM C. MINCHIN, M.D. (Bailliere, Tindall & Cox. 25*s*.).

The Earlier Inhabitants of London. By PROF. F. G. PARSONS, F.R.C.S., F.S.A. (Cecil Palmer. 10*s*. 6*d*.).

Pioneers of Wireless. By ELLISON HAWKS, F.R.A.S. (Methuen & Co. Ltd. 12*s*. 6*d*.).

William the Conqueror. By DORIS M. STENTON. (G. P. Putnam's Sons. 2*s*. 6*d*.).

Napoleon. By C. R. CLEARE, B.A. (G. P. Putnam's Sons. 2*s*. 6*d*.).

Joan of Arc and the Making of the French Nation. By M. ORLIDGE DAVIS. (G. P. Putnam's Sons. 2*s*. 6*d*.).

Religious Conversion: A Bio-Psychological Study. By SANTE DE SANCTIS. (Kegan Paul. 12*s*. 6*d*.).

The Stereoscopic Examination of Air Photographs. By LIEUTENANT M. HOTINE, R.E. (H.M. Stationery Office. 3*s*. 6*d*.).

Animal Biology. By J. B. S. HALDANE and JULIAN HUXLEY. (Oxford University Press. 10*s*. and 6*s*.).

The Locomotive God. By WILLIAM ELLERY LEONARD. (Chapman & Hall. 18*s*.).

The Nile and Egyptian Civilization. By A. MORET. (Kegan Paul. 25*s*.).

Food and Health. By A. BARBARA CALLOW. (Oxford University Press. 2*s*. 6*d*.).

Lares et Penates, or the Homes of the Future. By H. J. BIRNSTINGL, A.R.I.B.A. (Kegan Paul. 2*s*. 6*d*.).

This Airship Business. By E. F. SPANNER. (Williams & Norgate. 25*s*.).

Sovereignty: A Study of a Contemporary Political Notion. By PAUL W. WARD. (G. Routledge & Sons Ltd. 7*s*. 6*d*.).

Marc Lescarbot Nova Francia: A Description of Acadia, 1606. Translated by P. ERONDELLE, 1609. Introduction by H. P. BIGGAR, D.Litt. Edited by SIR E. DENISON ROSS and EILEEN POWER. (G. Routledge & Sons Ltd. 12*s*. 6*d*.).

Breaking Priscian's Head, or English as she will be Spoke and Wrote. By J. Y. T. GREIG, M.A., D.Litt. (Kegan Paul & Co. Ltd. 2*s*. 6*d*.).

Qualitative Analysis. By WM. WARDLAW, D.Sc., and FREDERIC WM. PINKARD, M.Sc. (Longmans, Green & Co. Ltd. 3*s*. 6*d*.).

The Origin of Instinct: A Study of the War between the Ants and the Termites. By E. BUGNION. Translated by C. K. OGDEN. Psyche Monographs: No. 1. (Kegan Paul, Trench, Trubner & Co. Ltd. 5*s*.).

English: From Piers Plowman to the Forsyte Saga. By JOHN L. YOUNG. Introduction by R. BRIMLEY JOHNSON. (W. & G. Foyle. 1*s*. 6*d*.).

Practical Psychology for Students of Education. By CHARLES FOX. (Kegan Paul. 7*s*. 6*d*.).

History of Radio Telegraphy and Telephony. By G. G. BLAKE, M.I.E.E., F.Inst.P. (Chapman & Hall. 25*s*.).

Atlanta, or the Future of Sport. By G. S. SANDILANDS. (Kegan Paul. 2*s*. 6*d*.).

The Biology of Insects. By GEORGE H. CARPENTER, D.Sc. (Sidgwick & Jackson Ltd. 16*s*.).

Man Rises to Parnassus. By HENRY FAIRFIELD OSBORN. (U.S.A.: Princeton University Press. $2.50. London: Oxford University Press. 11*s*. 6*d*.).

Physics in Medical Radiology. By SIDNEY RUSS, D.Sc., F.Inst.P., L. H. CLARK, Ph.D., F.Inst.P., and B. D. H. WALTERS, M.Sc., A.Inst.P. (Chapman & Hall. 12*s*. 6*d*.).

Tropical Agricultural Research in the Empire. By C. A. BARBER. Sc.D., C.I.E. (H.M. Stationery Office. 1*s*. 6*d*.).

Report on Development of Agriculture in British Guiana. By H. C. SAMPSON, C.I.E. (H.M. Stationery Office. 9*d*.).

Report of Development of Agriculture in Trinidad. By H. C. SAMPSON, C.I.E. (H.M. Stationery Office. 3*d*.).

DISCOVERY

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Editorial Notes.

IN publishing this month our Hundredth Number, we may glance back for a moment on the opening eight years of our history. This Popular Journal of Knowledge—to give it its full title—was the outcome of a conference called by the Presidents of the Royal Society and the British Academy, in which the principal learned societies and educational associations were represented, and in January, 1920, the first number made its appearance. Besides description of actual discoveries, some account is given of subjects which do not lend themselves to discoveries as ordinarily understood, but in which new methods and new points of view are being developed. Such were the objects expressed in the first editorial notes, when the magazine was published by Mr. John Murray on matte paper at sixpence. The desirability of half-tone illustrations made it necessary after the first year to print the magazine on art paper as a shilling monthly, a form that was continued when the present publishers took over the journal in 1924.

* * * * *

The founders of *Discovery* intended that all branches of knowledge should be dealt with from time to time, and that its articles should not be limited to science on the one hand or literature on the other. The Trustees, under whose auspices the journal is published, are therefore representative of classics and history as well as of biological and physical science; on another page they contribute their views on this anniversary, each message surveying the position from the particular angle of its writer. Of the numerous discoveries first announced in our columns three will serve to illustrate that the founders' object is being achieved. In the field of ancient studies, Professor Conway's article on tablets revealing a new fragment of Roman history may be recalled. In science, at the time of the first successful demonstration of television in April, 1925, the inventor contributed a description and invited financial support for a discovery which has since become known the world over. In historical research, we have introduced Mr. Ainsworth Mitchell's analyses of documents relating to Mary, Queen of Scots, which have thrown fresh light on the problem of her guilt; a new relic of the Queen's schooldays being the subject of an article this month. Among the congratulatory messages which we print in our Hundredth Number, we value particularly the opinion of Sir Oliver Lodge, whose predictions for the future appear to be well-founded in an issue which, in size at least, is more prosperous than any published hitherto.

* * * * *

The committee appointed last summer by the Secretary of State for Colonial Affairs to formulate a scheme for the creation of an agricultural, scientific, and research service for the Colonial Empire, has now issued its report. The bulk of the document is concerned with detailed proposals for central research stations and methods of staffing, it being recommended that the proposed Service should be divided into two wings, for research and administration respectively. A concluding section deals with the possibilities of agricultural development in the Empire, and points out that the welfare and progress of agriculture is to-day the most vital concern of almost every Colonial Administration. Agriculture, in fact, may be said to be the main industry of the Colonies, and on its efficiency depends, therefore, not only the food supply of the population, but all economic and social progress. Research does not stand still, and any country which lags behind in the application of the latest scientific knowledge to the practice of agriculture may suffer incalculable loss.

Recent figures show the remarkable expansion in Colonial trade which has taken place during the present century. In 1926 the total trade of the Colonies with which we are here concerned, which amounted in 1906 to £157,000,000, had grown to £485,000,000. Rapid and striking as this growth has been, we are as yet only witnessing its infancy. At present the trade of the Colonies depends on the agricultural activities of 50,000,000 people, a number which is small in proportion to the territory they inhabit, and its full development is still to come.

* * * * *

The publication of the "Life of Lord Curzon" has been described as probably the most important biographical event since Morley's "Gladstone," in that all the papers of a distinguished statesman are fully dealt with so near the events. The first forty years of Lord Curzon's life were unusually full, and Lord Ronaldshay devotes the first volume to them. Two other volumes will follow, the second covering the Indian Viceroyalty. In addition to the great series of journeys undertaken between 1883 and 1893, including two voyages round the world and explorations in Central Asia, Persia, the Pamirs, and Afghanistan, the whole of his comparatively brief House of Commons career comes within this period. Apart from these achievements Lord Curzon found time to write three books of outstanding merit on the people and politics of Central Asia, the Far East, and Persia.

* * * * *

Some critics have observed that Lord Curzon's correspondence was excessive and tedious in its detail. Apart from the fact that for the greater part of his life he wrote even official letters with his own hand, refusing the aid of secretaries and the typewriter, it appears that he derived peculiar pleasure from recording his thoughts and impressions. A result of this habit, which does not yet seem to have been remarked upon, may well have been the unusual memory he developed for detailed information—it is, of course, a commonplace that there is no surer aid to memory than the act of writing. Lord Curzon's letters are themselves a memorial to his industry, which, at least in respect of his correspondence, was maintained to the end. We may perhaps recall an undergraduate experience, not hitherto recorded, when Lord Curzon visited Cambridge to make a speech, and was there stricken with his last illness a few hours before the meeting he was to have addressed. The members of a university club of rival political colour who sent him some flowers received immediately a warm acknowledgment, written in pencil from the sickbed.

1920-1928: 100th Issue Messages.

From Sir J. J. Thomson :—

" As I have been prevented by the pressure of other duties from taking more than a merely nominal part in the development of *Discovery*, I am free to express my appreciation of the work of those— the Editors, the Contributors, the Committee, and the Publishers— to whose efforts the success of *Discovery* is due.

" The work has not been easy ; there have been strenuous times when the prospect seemed dark and the difficulties depressing. But even in the darkest days the bigh standard for the articles with which we started was never lowered. These articles have ranged over many departments of knowledge, literature ancient and modern, the physical and biological sciences, archaeology, and anthropology. For my own part I have always found *Discovery* excellent reading and that it widened both one's interests and one's knowledge."

J. J. Thomson

From Sir Frederic Kenyon :—

" As a Trustee of *Discovery*, I respond with pleasure to the suggestion that I should send a word of greeting to its hundredth number. *Discovery* owes its existence, and its survival through a difficult period, mainly to the zeal and vision of Professor Conway. The other Trustees (I think my colleagues would agree) have taken a less active, though not a wholly sleeping, part in its development, but they have from the first represented the lively interest in the project of those concerned in the progress of natural science and of humanism.

" I hope it is gradually establishing its position as the recognized organ of authentic information on the progress of research, told by experts in terms intelligible to the non-specialist. In these days all are alert to hear of new discoveries which advance the borders of human kowledge, whether forward into the mysteries of biology or backwards into the pre-history of our species, or yet further back into the abysses of geological or astronomical

time. All such widenings of our horizon increase our culture and make us more intelligent and therefore more useful citizens. But since we cannot ourselves be experts in all, or perhaps in any, directions, we want our information on these topics to be at once authentic and intelligible; and for such information we are coming more and more to look with confidence to *Discovery*. It fills now a recognized place in our mental equipment. May its hundredth number, with the aid of its sympathetic editor and publisher, be but the opening of an ever-widening career of usefulness."

Frederic G. Kenyon.

From Professor A. C. Seward:—

"The publication of the hundredth number of *Discovery* is an event which affords a legitimate excuse, to those of us who are interested in what we believe to be work for the good of mankind—work it may be that we follow as sympathetic onlookers without doing much to further it by personal service—for proclaiming to the world the fact that the journal has successfully passed through the most critical period in its development, and has reached a stage at which we may confidently prophecy many years of vigorous life. *Discovery* has not only continued to exist; it has been able firmly to establish itself as an efficient part of that complex piece of mechanism with which we may compare the numerous periodicals concerned with the dissemination of knowledge, and let us hope knowledge which in some instances leads us on to wisdom.

"In these days of unavoidable specialization, when those who are trying to advance science publish the results of research in language intelligible only to a small number of experts, it is essential that efforts should be made to present in language which the layman can understand some of the advances in biological science. *Discovery* has played its part in spreading the gospel: it has endeavoured to illustrate by well-chosen examples what biology means; it has shown how in many instances pure science—facts or principles discovered with no ultimate aim other than the search after truth and the interpretation of the mysteries of nature—is the foundation of progress in applied science. It has also, one may add, added to the happiness of many readers by introducing them to the inner courts of knowledge; by providing material which stimulates the imagination and in creating an ambition to contribute by personal observation or experiment to the sum of natural knowledge."

A. C. Seward

From Professor R. S. Conway:—

"In the best farmyards it is understood that however excellent the egg, the cackle of the hen that laid it must be neither too loud nor too long; and those who were concerned with the foundation of *Discovery* must be content to express briefly their pleasure in seeing it reach its hundredth number. As readers of its early volumes know, it sprang from the general desire, particularly manifest at the end of the war, for greater co-operation between the friends of knowledge. Men of very different pursuits joined in the effort to arouse and increase popular interest in research and its results. The value of this central purpose has proved great enough to carry the journal through some vicissitudes of fortune; and it enters on its ninth year with a happy record of service rendered to all sides of knowledge in all parts of the world.

"Taking from Shakespeare our guiding principle of 'looking before and after,' we have done our best to encourage both the studies that relate to the past, of humanity or of the organic and physical world, and the studies that reach out to the future of them all. Not the least of our good fortune has been the liberal sympathies of the two great publishing houses which have supported the venture, and also, if I may be allowed to say so, the valuable and singularly diverse gifts of its successive editors who have vied with one another in the zeal which they have devoted to the work."

R. S. Conway

From Sir Oliver Lodge:—

"*Discovery* is an admirably conducted paper and fills a felt gap. It combines literary and scientific instruction, and must be welcome in many homes. Let me congratulate all concerned in its production on its success and hopeful outlook, and wish it continued usefulness and success."

Oliver Lodge

A New Relic of Mary, Queen of Scots.

By C. Ainsworth Mitchell, M.A., F.I.C.

The discovery of what is probably the earliest writing of Mary, Queen of Scots, suggests that the "Casket Letters" attributed to her at the time of her trial were not genuine, thus supporting previous such evidence.

A FEW months before his death Dr. Walter Seton asked me to co-operate with him in determining

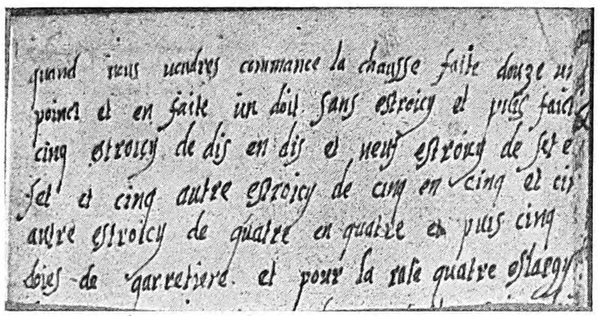

FIG. 1
THE FIRST WRITING IN THE BOOK.
Top of the first fly-leaf at the end of the book, the writing being directions for knitting, a craft at the time introduced into France from Scotland.

whether some writing in an old book was or was not that of Mary, Queen of Scots. As he died before the investigation was complete, I have finished it alone, but even after the preliminary examination Dr. Seton regarded the evidence which I put before him as very convincing.

The book in which the writing occurs is a copy of Polydore Virgil* in Latin, published in 1528, and it is interesting to note that Mary was a good Latin scholar, and that Dr. Seton learned that Polydore Virgil was one of her school books. The writing, which is on two fly-leaves at the end, is not of any intrinsic importance, being merely directions for the knitting of a stocking (Figs. 1 and 2), but it has some subsidiary interest as being probably one of the earliest descriptions of knitting, which, according to the tradition, had only been invented at the beginning of the sixteenth century, and had been introduced into France from Scotland. It would thus have been quite likely that "notre petite Reinette d'Escosse," as her French cousins called her, should have learned a Scottish craft.

It will be remembered that Mary had been sent to France when only six years old, partly to protect her from the schemes of the English, who wished to marry her to Edward VI, but principally that she should be trained by the Queen of France, the notorious Catherine d' Medici, until old enough to marry Francis, the French Dauphin, and so eventually by uniting the two kingdoms to make Scotland a dependency of France.

Dr. Seton attributed this writing to about the year 1555, when Mary would have been thirteen years old, but as it is rather more unformed than her writing of that year, even after making allowance for the fact that her formal letters to her mother, the Queen

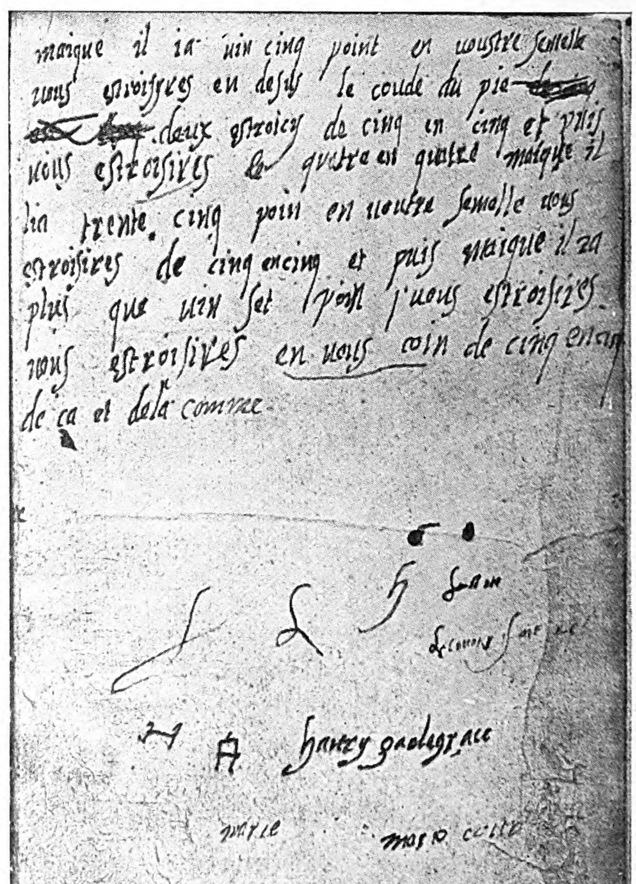

FIG. 2.
THE SECOND FLY-LEAF, INCLUDING SIGNATURE.
This continues the knitting directions, and after some scribbled signs the signature "Marie" is appended. The pen characters are important in comparison with the writing on other documents (see Figs. 3 and 5).

* Polydore Virgil (c. 1470-1555), born at Castro in Etruria. Naturalized in England, 1510, and became Archdeacon of Wells and a Prebendary of St. Paul's Cathedral. Died in Italy about 1555. He wrote a book of proverbs, a book on the origin of all things ("De Inventoribus Rerum, 1499"), and an English history in twenty-six books, first published in 1534.

Regent of Scotland (see Fig. 3), are carefully and neatly written, I should be inclined to put the date a year or two earlier. Some of these early letters may have been written under the supervision of Madame Parois, the mischief-making governess whom Cardinal Lorraine had chosen to mould the views of his niece in the direction of French interests, but others could not have been, for the governess would hardly have allowed complaints about herself to pass (see Fig. 3).

Throughout her life Mary's admitted handwriting shows distinctive characteristics, which it shares with the writing in the book, but for comparing the formation of individual letters in any writing it is necessary to select specimens of approximately the same period. I therefore chose for this purpose a letter written in 1555 (Labanoff, "Lettres de Marie Stuart," Vol. I, pp. 29-32), the original of which forms part of the Balcarres papers in the National Library of Scotland. Among the general characteristics common to the writing in Mary's letters, and to the writing in the book, are the following:—In both the lines follow a wavy course, the letters now rising above the base line, now falling below it. In both may be found a curious increase or decrease in the size of letters in various words; sometimes both increase and decrease occur in the same word. In both there are similar habits for the dotting of the "i's," the dot being sometimes placed to the right, sometimes to the left, sometimes vertical and sometimes omitted. Then there are similar numerical relationships between the different parts of letters. For instance, the cross-stroke of the "t" (not always crossing the upright) are at approximately the same relative heights (which vary in both writings), and the same similarity is to be seen in the cross-stroke of the "f."

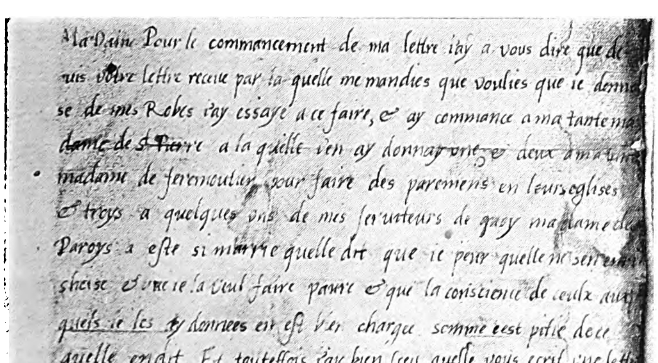
Madame Pour le commancement de ma lettre iay a vous dire que de
uis votre lettre receue par la quelle me mandies que voulies que ie donn
se de mes Robes iay essaye a ce faire, & ay commance a ma tante ma
~~dame de S. Pierre~~ a la quelle ien ay donnay une & deux a ma ta
madame de fermoutier pour faire des paremens en leurs eglises
& troys a quelques uns de mes serviteurs de quoy madame de
Paroys a este si marrye quelle dit que ie peur quelle ne sen em
scheise & que ie la veul faire pauvre & que la consience de ceulx aus
quels ie les ay donnees en est bien chargee somme cest pitie de ce
quelle en dit. Et toutefois iay bien sceu quelle vous ecrit une lett

FIG. 3.
MARY'S LETTER TO HER MOTHER, 1555.
In this the young queen complains of her governess Madame Parois. The script aided in the identification of the new writing, shown side by side in Fig. 6.

FIG. 4.
MARY AS A SCHOOLGIRL.
Portrait executed while Mary was in France. (Reproduced by permission from Andrew Lang's "Mystery of Mary Stuart.")

The letter "u" is used in place of "v" throughout the knitting directions, with one possible exception; the same substitution is to be found in several places in the carefully written letters. Similar variations in spelling are common to both writings. Thus "commance" is used in both (reverting later to "commence" in the knitting directions).

Some of the numerous resemblances in the forms of the letters are shown in Figs. 5 and 6. In fact, almost every form of letter in the writing in the book can be matched in the letter. The wording on the second flyleaf in the Polydore Virgil (see Fig. 2) has several points of interest. There are a few childish scrawls, followed by "Hanri par le Grace"—an allusion to Henri II, Mary's future father-in-law. The date is given as "Mai 10," but without the year, and there is apparently the beginning of the word "couvent," followed by the signature "Marie."

Two of Mary's aunts were abbesses of the Order of St. Peter, one at Rheims and the other at Fermoustier, and there is an allusion to them in Mary's letter to her mother (Fig. 3). The writing in the book thus suggests that it may have been written while Mary was staying in the convent of one of these

*

aunts, although, as Agnes Strickland points out, her usual home was in one of the royal palaces.

The signature agrees in its general characteristics with admitted signatures of Mary (Fig. 5), and it is interesting to note that if the succeeding strokes

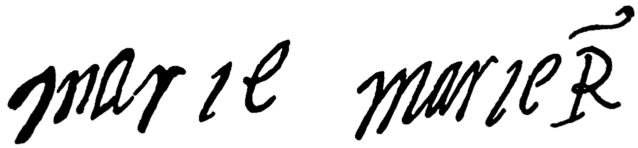

FIG. 5.
MARY'S SIGNATURES.
On the left is an enlargement of that in the book; right, in the letter, now at Hatfield House, written to Queen Elizabeth.

are measured and plotted, as suggested by Fraser and more recently by Locard, as a curve, the shape of this curve agrees closely with that of an undoubted signature of the Queen on a letter written to Queen Elizabeth some thirty years later. This could hardly be a coincidence, especially as the formation and angles of the letters in the two signatures also agree.

The undulations in a line drawn along the bases of the individual letters in the two signatures afford a striking illustration of a characteristic trait of Mary's writing already mentioned. Even the variations in form are suggestive. For instance, the "a" in the signature in the book has the pointed base found in the "a" in "commance" in the letter of 1555, whereas the round "a" in the admitted signature (Fig. 5) is of the type of the "a" in "commance" as written in the book (Fig. 6). These writings of Mary as a young girl have some small evidential value in connection with the notorious "Casket Letters." When the French versions of these letters, produced before the Commissioners appointed by Queen Elizabeth to investigate the charges against Mary, Queen of Scots, were discovered, about 1870, they were subjected to a critical analysis by Lettenhove, who condemned them as forgeries on the ground of the style of the French, the bad grammar, and the bad spelling.

Professor Neale, however, contends (*History*, 1927, 12, 42), that Lettenhove's arguments were destroyed by Bresslau, who (according to Professor Neale) concluded that several of the letters must be genuine, and that the damning letter No. II was "partly genuine." But the facts do not support this contention, for Bresslau, who was a professor at Berlin, while citing numerous passages in common between Mary's admitted letters and the Casket Letters, does not assert that Letter II is partly genuine. His words "zum Theil" refer, not to the letter itself, but to some hypothetical document. What he does say is that Letter II is a forgery "partly based on a genuine foundation," and that since this letter must be rejected, direct proof of the charge against Mary falls to the ground. In controversy an inaccurate translation is a dangerous weapon to use!

As Andrew Lang pointed out, the question of the style of the letters is not a conclusive argument in either direction, since a forger would presumably take care to introduce passages from genuine letters of the Queen into his work. Much more weight must be attached to the evidence of the grammar and spelling. Lettenhove's argument, which Bresslau does

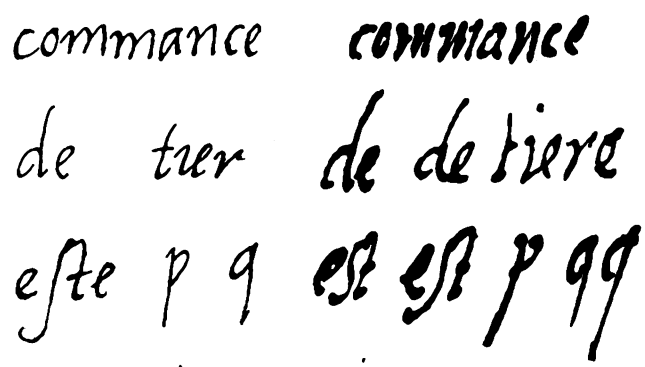

FIG. 6.
PHOTOGRAPHIC ENLARGEMENT OF LETTERS AND WORDS.
(Left.) In Mary's letter to her mother written in 1555. (Right.) From the book.

not even attempt to refute, is that a woman whose mother-tongue was French, who had been educated in France, and who had known intimately the most cultured Frenchmen of the period, would not have fallen into grammatical blunders, such as making *nouvelles* masculine, and *estat* and *amendement* feminine; nor would she have misspelled words, such as *j'envoy*, *contrair*, *sens*, etc., seeing that in her admitted letters she wrote *j'envoie*, *contraire*, *sans*, etc.

It is significant that even as a child of eleven or twelve Mary did not spell *sans* as *sens* (Fig. 1), and thus what is probably her earliest writing extant supplies presumptive evidence that the Casket Letters attributed to her some fourteen years later were not genuine.

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Saqqara, the Cemetery of Memphis.

By S. R. K. Glanville, M.A.

Department of Egyptian and Assyrian Antiquities, British Museum.

The excavation of Saqqara has afforded details of an ancient cemetery second in size only to that of Thebes. A fascinating chapter in the history of Egyptian architecture is now revealed.

During the last five years the Egyptian Government has been carrying out excavations at Saqqara, a dozen miles south of Cairo, which are still in progress under the direction of Mr. Cecil M. Firth, of the Antiquities Service. The time has now come when a general view of the work up to date may be obtained, and some account given of the implications, architectural and historical, that follow from them.

Saqqara comprises several pyramids, a very large number of private tombs of all periods, and the two, much later, Serapeums, on the edge of the high desert west of the Nile opposite Badrashēn, besides a village or two at the foot of the hill. A necropolis second in size only to that of Thebes, barely an hour and a half distant from Cairo, it was until quite recently probably the least visited ancient site in Egypt. The main attraction was the Step Pyramid of King Zoser and the Serapeum, the underground burial place of the sacred Apis Bulls. There was some justification for this comparative neglect. Saqqara is but the cemetery of a mighty city which once spread at its feet as far as the eye could see, but which has now scarcely one block of masonry upon another to mark its greatness. Several years of laborious excavation before the war enabled Sir Flinders Petrie to recover the probable plans of a few of the more important buildings, as well as odd fragments of masonry of various periods, and a number of smaller objects of archaeological interest. But on the whole the results were extremely disappointing, and to-day the only ancient monuments which strike the eye of the traveller crossing from the river to the desert—an hour's ride on a donkey—are two fallen colossal statues of Rameses II and a weathered sphinx. Yet Memphis was undoubtedly the most important city in ancient Egypt; and perhaps it is now no more only because, in a land where successive generations build their houses on the ruins of their fathers', it was to be expected that sooner or later the pitch would become too worn with such constant use. As in other countries, suburbs have become county towns; so, first Fostat and later Cairo became capitals of Egypt, and Memphis faded away to the cultivated land from which it sprang, with only the mud village of Mīt Rahīneh to mark its site.

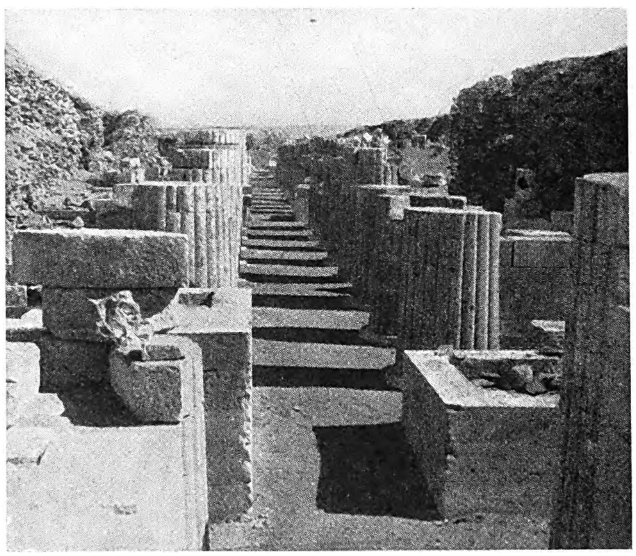
THE STEP PYRAMID OF ZOSER.

The famous pyramid is here seen from the south-east. The buildings unearthed in the foreground are a series of small chapels which lined the west side of the Jubilee Hall.

There is evidence that there was some sort of town at this spot in predynastic times. It was clearly refounded, probably on an enlarged scale, by one of the First Dynasty kings, perhaps Merpeba. At the beginning of the third dynasty, *c.* 2800 B.C., it became the capital of Egypt. It maintained this position till the end of the Old Kingdom, say for about 500 years, and though suffering mixed fortunes in the First Intermediate period, was second only to Thebes during the Middle Kingdom. With the exception of the period of the eclipse of Egypt during Hyksos' rule, Memphis remained, from that time to its gradual decay under the Byzantine emperors, politically never less than second and from time to time the first city in the kingdom, and commercially the leading centre in North Africa till the rise of Alexandria. The main cause of its continued greatness was its geographical position at the head of the Delta, whence it controlled the navigable waters of the Nile.

The main objective of the excavations at Saqqara during the past few years has been the pyramid area of Zoser, *i.e.*, the famous Step Pyramid and all that lies between it and the *temenos* wall which bounds the "Pyramid estate." It will be convenient to examine the main buildings thus brought to light in the order of their discovery—they happen also to run from north to south—beginning with the pyramid itself.

This tomb of the Pharaoh Zoser was the first, so far as we know, to carry the old *mastaba* tomb of earlier kings a stage forward by increasing the size of the building by the addition of diminishing platforms. The total height of 200 feet thus appears to be made up of great steps, of which there are six; though in reality the additions to the original structure are in a lateral not vertical direction. The new excavations aimed chiefly at clearing the network of passages in the pyramid made by the thieves of later generations in search of the royal builder's treasure. Though interesting to the engineer, they hardly concern us here. What is more important is the discovery of quantities of fine dressed limestone, once the covering of the existing "steps," which are made of the coarse and friable limestone on which the building stands. This finer stone was definitely no more than a covering; and the original pyramid must have displayed much the same stepped form as we see to-day, but with slightly different proportions. The final stage in the evolution of the pyramid-form did not come till the next dynasty, when the steps were made smaller and correspondingly more numerous, and the covering was so cut as to form, when in place, a straight line from top to bottom.



THE ENTRANCE COLONNADE.

View looking east along the magnificent entrance colonnade. The grooved columns are joined two by two, with a narrow strip of wall between each pair.

At the north-east corner of the Step Pyramid two smaller pyramids or enlarged *mastabas* in a somewhat amorphous state of ruin indicated the burial places of royal persons, since they were inside the *temenos* wall. The excavations revealed, against the north wall of each of these *mastabas*, a chapel for the cult of its owner, probably the Princesses Intkaes and Hetephernebti respectively. With these chapels the series of important architectural discoveries begins. The chapel is simply an open court with its back wall against the *mastaba*, and in the centre of that wall a small *cella*, or recess, to receive the food offerings for the dead princess. The workmanship is a very different story. First, the columns set in the back wall are entirely unexpected at this period. It is true that they are only here half-columns, forming an integral part of the wall, but from their use in the entrance colonnade to be described below, it is clear that the principle of the free-standing column was already appreciated—about two hundred years before the period of the Fifth Dynasty temples where it had been supposed that the round column first came into use. And that was still the smooth-surfaced column in direct imitation of the tree-trunk (palm); whereas in the reign of Zoser we are getting the fluted variety, whose discovery it was customary to ascribe to the Middle Kingdom builders of the tombs at Beni Hassan and Assuan, nearly a thousand years later. Secondly, the capitals of these columns are unlike anything found in Egypt or elsewhere. They resemble two long leaves falling from the top, one on either side of the column, and lying close to it.

Though strange to our eyes they are not inelegant, and a rather similar device is to be found on the tops of chair legs in some of the early English work of the last century! Thirdly, where the walls join at the corners a ribbed panel juts out for a short way. This was painted red, the whole panel being probably in imitation of the doubling of the uprights to strengthen the corners of a wooden house.

The next complex of buildings to be unearthed, south-east of the pyramid, was a large courtyard, lined on the side nearer the pyramid with a series of small chapels, each consisting of two narrow chambers parallel with one another and the back wall. The exact nature of these little chapels or, indeed, of the whole of this remarkable building, is not known, though there is evidence to suggest that it was in

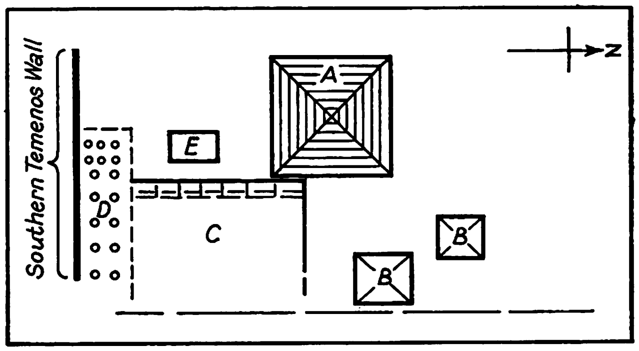
some way connected with the " Hebsed " festival, one of the earliest traditional Egyptian rites at which the king celebrated the anniversary (at one time only the thirtieth) of his accession to the throne. For this reason the building has been provisionally called by its excavators the Jubilee Hall. The fluted columns with double-leaf capitals already described are found occupying a similar position in the back walls of these chapels. But the capital has an interesting addition in the form of a hole between the leaves to carry a copper spout from the flat roof at the back to the front of the column. The purpose of this may have been simply to carry off the water from the roof, but more probably it was to supply to each chapel its own water for use in the cult. Yet more interesting are the dummy doors leading into the chapels, and the partitions separating the individual cells of the chapels from their neighbours to north and south. These doors are of solid stone, but set open—at various angles—and unmovable. They were, in fact, not real doors at all, but dummies. Moreover, they are made to show the circular ends of crossbars in their thicknesses, as if they were of wood. The partitions inside are even more completely in imitation of wooden originals, the upright posts and the crossbars into which these fit being all shown. Thus the main features of these buildings are a direct interpretation in stone of a timber technique.

West of this Jubilee Hall is a small building whose purpose is equally uncertain. Its plan is even more unexplicable, but as it contains no important details save some more dummy doors, we may pass on to the last important building inside the *temenos*.

The Entrance Colonnade.

This is the magnificent entrance colonnade, which runs from the eastern edge of the *temenos* towards the west, just inside the southern *temenos* wall. Here the columns, though still not entirely free-standing, are joined two by two, a narrow strip of wall between each of a pair in order to give strength to the whole construction. But it is impossible not to believe, with the excavator, that this buttressing wall followed and did not precede the conception of the free-standing pillar. It will be seen from the photograph that the pillars themselves in this case are not fluted, but grooved so as to produce in section a series of convex curves, resembling the common imitation of bundles of papyrus or lotus stems in later times.

The next step in the excavations, and the last to be discussed here, is the southern *temenos* wall itself, whose outer face is carried out in a style not found anywhere else in stone. Apart from the imposing



SKETCH PLAN OF RECENT EXCAVATIONS.
A. Step Pyramid. BB. Princesses' Pyramids. C. Jubilee Court. D. Entrance Colonnade. E. Small building with dummy doors, purpose uncertain.

front which it affords to the whole pyramid enclosure, the facing of this wall has a special interest because of its close similarity with the recessed or panelled mud-brick walls of certain earlier buildings at Abydos in Upper Egypt. Nowhere in Egypt do the known brick buildings carry out the idea of the recessed wall in so much detail as in this stone building, and we must go to the Ziggurats of early Mesopotamia for the closest brick parallels. It is, indeed, most probable that the Egyptians learned not only this peculiar brick style of building, but even the very knowledge of brick-making from the early Sumerian inhabitants of Mesopotamia. It is in the thickness of this southern *temenos* wall that an important tomb, whose first rooms have already been opened, is at present being excavated. It would be unwise to discuss the information we have of it as yet, but it is worth noting that the decoration of the first rooms with oblong fayence tiles in two sizes is in imitation of reed mates, the regular wall hanging of houses of that period, and undoubtedly gives us the origin of the border design of the greater part of the later scenes, in tombs on stelae, and even on smaller objects—a design which was borrowed by the Greeks for entablatures, and has come down to us in architecture and on furniture.

An unexpected feature of the work at Saqqara is the discovery that the stone used for all the buildings that have been discussed, except where it was stated to have been of the coarse local variety, is the fine white limestone from the quarries at Tura, a few miles down the Nile from Memphis, on the east bank. The effect of all this fine stone building in the light and soot-free climate of Egypt must have been brilliant, and the labour involved in its cutting and transport from the quarries (not to speak of the actual building) is hardly less startling to contemplate. In the matter of transport a peculiar interest attaches to a small piece of papyrus found in the excavations, on which is written a letter from a senior military officer in charge

of a gang of soldiers on quarry duty at Tura to a high official of the court at Memphis. The letter is about two hundred and fifty years later in date than our buildings. Its burden is that, in the opinion of the writer, the order to send his men to the capital to have new uniforms issued is quite unnecessary; it means the waste of a day, and when he sent them a week before for the same purpose, they were kept hanging about and then sent home empty-handed. The innuendo is that the kit should be sent to *them*. Add the obstruction of official red tape to the mere mechanical difficulties of transporting the stone, and it is clear that the building of Zoser's pyramid was no mean undertaking for his great architect, Imhotep.

Building Technique.

With regard to the implications of these remarkable discoveries, the clear descent of the style of the southern *temenos* wall from the early Sumerian constructions in brick, through Egyptian in the same material, has already been noted. At this time the use of wood and wattle and daub for houses was complementary to that of brick for larger or permanent buildings, and those also we have seen imitated in the fine stone work at Saqqara. Prior to the time of Zoser, the only known instance of building in stone was the flooring of a single First Dynasty tomb. It would appear then that stone building had sprung suddenly into existence in Egypt at an advanced stage! It is recorded, however, on the Palermo Stone that Neneter, a king of the Second Dynasty, built temples in stone. This might mean that the period from Neneter to Zoser, short as it was, brought the new architecture into being and to the remarkable power which we see it had already obtained at Saqqara. But the facts seem to warrant a wider and more probable hypothesis. The art of the architect and the craft of the stonemason may indeed have been developing in the Delta (where any monuments which might prove this have long since been covered in Nile deposit) since predynastic days, while in the south brick remained the only medium for solid building. For Ptah, the patron god of craftsmen. and especially of builders, was a Delta god, whose seat at the White Wall, the predynastic town which later became Memphis, doubtless marked the southern limit of his sway. The origin of this god is unknown, but it is conceivable that he was the craftsmen's counterpart in Syria to the shepherd god Osiris, and that the two came into the Delta together with the people which gave Egypt such a distinctive turn towards the end of the predynastic period. At all events, stone is the natural building material in Syria, and Ptah is certainly to be connected with the knowledge of it as such in Egypt. The facts fit the hypothesis well. The White Wall appears at about the time when this new people has established itself in the Delta. The conquest of the North by the South, resulting in the first united dynasty, produces a series of brick buildings but only one floor of stone, and necessitates the refounding of the White Wall (Memphis) apparently without the use of stone, indicating that this first union was merely political. Its unreality was shown by the rebellion in the Second Dynasty, when, under the rule of a united Egypt by Delta kings, we again hear of buildings in stone (Neneter). The reconquest of the North by the South at the end of the Second Dynasty, and the establishment at the beginning of the Third, of the White Wall as the capital, brings us to the first existing stone monuments—for by this time the two cultures were sufficiently intermingled for the conquerors to adopt the more durable building material of the conquered. But they still cling to the *style* of their old materials—brick, wood, wattle and daub. By the Fourth Dynasty a great deal of that has dropped out, and the stonemasons are working out their own styles in much larger blocks of stone. For the work at Saqqara is characterized by a rather small size of blocks, in marked contrast to the megaliths of the Gizeh sun temple—perhaps another concession to the brick-layers from the south.

Hybrid Architecture.

This remarkable hybrid architecture thus brought into being in Memphis, though logical in its origin, must have required a genius to give it actual expression on such a large scale. Later Egyptian tradition which deified Imhotep as a god of healing, acclaimed him also as the great architect, builder and councillor of Zoser, besides crediting him with a number of the highest offices in church and state. During the excavations at Saqqara the base of a statue of Zoser was found bearing the name of Imhotep. The mention of a private person on a royal statue is unprecedented, and all the more remarkable in this case because the inscription gives Imhotep none of his traditional titles, so that it appears that he was still in the early stages of his career. But it is impossible to doubt that the statue refers to the man who was afterwards deified. It has recently been brilliantly suggested by Dr. Scharff of Berlin that it was at about this time—and not, as is usually stated, in 4241 B.C.—that the calendar was founded, and that Imhotep was its inventor. This agrees very well with his being both the architect and sage of his day.

Cat's Cradles, The World's Most Widespread Game.

By James Hornell, F.L.S., F.R.A.I.

The game of Cat's Cradles is played the world over, and it is not improbable that it afforded a pastime to our ancestors of the Stone and Bronze Ages. A complete record of its occurrence before it becomes obsolete is needed in the interests of ethnographical knowledge.

UNTIL the beginning of this century scarcely anything was known or recorded of the vast variety of games played in many lands with a closed loop of string, the first cousins of the cat's cradle of our own youth, although these are now coming to be recognized as of much importance in ethnological research. Two causes were responsible for this. Writers and observers either considered them in the light of children's trivial play, or, more usually, were actually unaware of their existence among the people they were treating of or studying. It is an extraordinary and yet everyday fact to find that intelligent men who have resided many years in out-of-the-way parts of the earth, and who are credited with intimate knowledge of native customs, are ignorant of the existence among the people of such games, even when these are extremely numerous and highly specialized. Time and again have I found this curious ignorance. For example, when in Samoa a few years ago, I was introduced to an official who had spent many years in the island on terms of great intimacy with the natives, and of whom it was said " he knew *everything* about the customs of the natives." He laughed at the idea of the Samoans playing cat's cradle games and assured me they never did. To make assurance doubly sure, he called into his office an elderly Samoan, who, he said, would certainly know if any such thing existed. The native listened attentively and then concurred with his superior's dictum. A few minutes later, when passing a fisherman's house some hundred yards away, a fishing net attracted my attention. The owner came out and, after answering my questions, invited me within. Sitting with him on the mat floor, I bethought me of my string and began to make an easy figure. My host's face lit up; eagerly lifting the string from my hands, he exclaimed, " I show you Samoa game." And sure enough he did—the first string figure to be recorded from Samoa. From school girls at the Apia convent I learned several more, and it is significant that the Sisters in charge had never before seen the girls playing these games. Similar instances are common elsewhere. Natives show a peculiar and curious reticence in regard to these games, due largely to their fear of ridicule for indulgence in a pastime which they fancy the materialistic white man would be apt to consider childish.

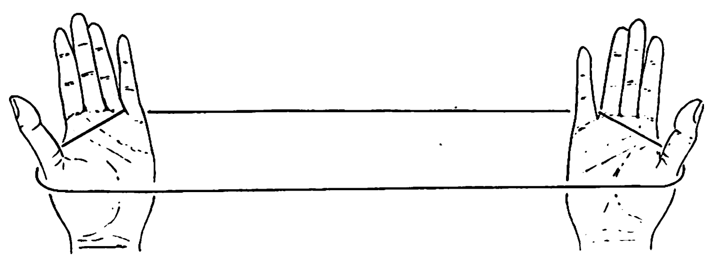


FIG. 1.

CAT'S CRADLE, FIRST POSITION.

Conversely, if the white man is acquainted with some of these games, there is no quicker way to gain the confidence of shy or suspicious natives than to sit down amongst a group of children and amuse them by weaving some pretty or quaint figure with a loop of string. Such a man, they feel, cannot be suspected of guile. A friendly feeling is quickly established, and usually the women and children clamour to have the privilege of showing the stranger some of their own skill in this art of fashioning string figures.

It is comparatively easy to learn to weave many of these patterns, but to record them in words was difficult till Drs. Haddon and Rivers in 1902 published a simple set of technical terms. With the help of these the most intricate games may be recorded clearly and made available for comparative study with those of other localities.

Before putting before the reader a few examples it will be necessary to define concisely such of these terms as have to be employed. Thus a string crossing the palm of the hand is described as *palmar*, that across the back as *dorsal*; a string on the thumb side of any digit is termed the *radial* string, that on the little finger side the *ulnar*. When no confusion can be caused, as when the hands are held upright with the palms facing each other, *near* and *far* may be substituted for radial and ulnar. Three other terms for positions and movements common to many figures are also

conveniently employed. They are the following, viz.:—

Position 1. Place the string around the back of the thumb and of the little finger of each hand in such a way that the part between passes across the palm of the hand (Fig. 1).

Opening A. Assume position 1, then with the back of the index finger of the right hand pick up, from the under side, the left palmar string and return to the original position. Do the same with the index of the left hand; the figure now consists of three loops on each hand—a loop consisting technically of two strings, a radial and an ulnar.

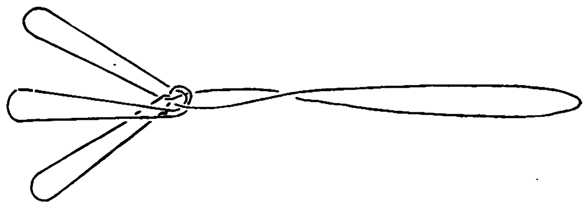


FIG. 2.
BALAWA, THE SCREW-PINE.

Navahoing. Sometimes two loops are found on one of the digits, the higher being the ***distal***, whilst the lower, the one nearer the wrist, is termed the *proximal*. To Navaho, is to lift the lower or proximal loop over the higher or distal one and over the tip of the digit and then to drop it, drawing all strings taut thereafter.

Before discussing the distribution, local characteristics and ethnological significance of string figures, the description of a few representative examples will enable the argument to be followed more easily. Those selected are from the South Sea, where this pastime has reached a surprising degree of development. I premise that at the end of each stage or movement, the hands are to be drawn apart to the original position and the strings tightened. The loop of string used should be from $6\frac{1}{2}$ to 7 feet in length, and the ends neatly joined together; a fairly stout twine is preferable.

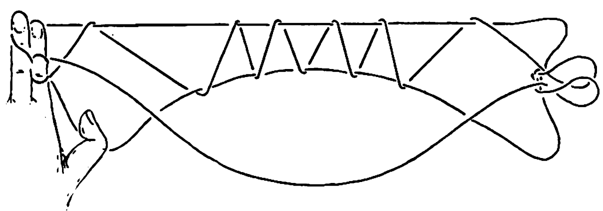


FIG. 3.
FANENE'S SKIPPING-ROPE.

I. BALAWA, THE SCREW-PINE. This is one of the simplest of Fijian figures.

(1) Assume position 1. (2) From below pass the right index under the left palmar string and draw this out, giving the loop thus formed a complete twist by rotating the index under it. Return to position. (3) Pass the left index through the loop on the right index and with its back pick up, from below, the right palmar string and return. (4) Drop the thumb and little finger loops of the left hand and draw the hands apart. A three-leaved branch is the result; in New Guinea this figure is called "fish-pear," in Samoa, the "three-toed duck."

II. FANENE'S SKIPPING-ROPE. A very effective and pretty game hailing from Tongatabu in the Tongan archipelago.

(1) Extend the string upon the index fingers. (2) From above take the far string at the middle point between the lips and draw it back. (3) Passing over the right-hand mouth string, catch up the left-hand mouth string on the back of the right index and return to position; similarly catch up on the back of the left index the right-hand mouth string, passing *over* (distal to) the left-hand mouth string in so doing. Release the string held in the mouth. There are now two loops on each index. (4) Pass each thumb over the lower near index string and take upon its back the lower far index string and return. (5) Repeat the movement upon the upper index strings. (6) Bending the middle fingers *over* the upper index radial string, take up on their backs the lower index radial string. (7) Each middle finger is now within a small triangular space. With the lips lift off the string passing across the palmar side of this finger, releasing the string passing around its dorsal aspect, and slip the former string over the tip of the same finger. Repeat three or four times on each hand. (8) Place the thumb from above upon the palmar string of this twisted loop, press down, release the strings on the thumbs and extend.

It will be found that one of the released thumb strings hangs loose and may be thrown backwards and forwards over the stretched figure—Fanene's Skipping-rope.

III. TENIOKO'S GATEWAY.

(1) Make Fanene's Skipping-rope, hanging the loose string pendent on the far side. (2) With the thumbs which press down the palmar strings of the twisted loops, catch up upon their palmar faces the loose strings of skipping-rope, and hold it down together with the companion string. Extend the figure, turning the palms outwards.

The result is a well-defined archway. If desired, the number of loops on the arch may be increased by giving more twists to the middle finger loops when making the Fanene figure.

In many instances long series of figures are made, analogous to those of our own cat's cradle, but much more ingenious and diversified. One of the most effective is the Fijian *Rara-ni-kula* (Parrakeets' Playing-ground) series. The first three figures of this will now be described.

IV. Rara-ni-kula.

(1) Opening A. (2) Pass the thumb and last three digits of each hand into the index loop of the same hand from the under side, and then by bending all digits outwards, pass the index loops over the back of the hands and down to the wrists. (3) Insert the thumbs into the little finger loops from below and return with the little finger radials on their backs; similarly pick up the thumb ulnars upon the backs of the little fingers. (4) With the thumb and index of the right hand, lift off the double palmar loop from the left hand; slip the left hand downwards out of the wrist loop and with the left thumb and index pass the released wrist loop from the lower side through the free left palmar double loop, now held in the fingers of the right hand; replace the double loop in its original position on the left hand, and place the former wrist loop upon the left index, to form an index loop. Proceed similarly with the double palmar strings and wrist loop of the right hand. (5) Extend, keeping the strings taut and incline the hands towards one another so that the fingers are about 35 degrees from their original position.

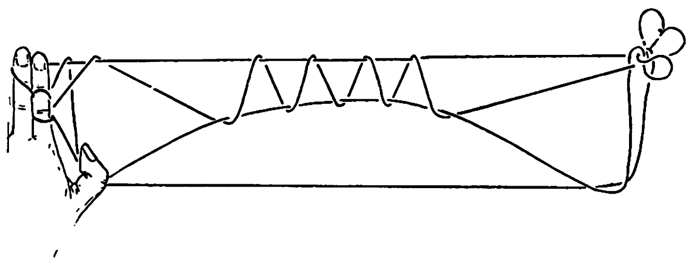


Fig. 4.

TENIOKO'S GATEWAY.

The net-like figure produced is the *rara* or green where the Parrakeets love to chatter and preen themselves.

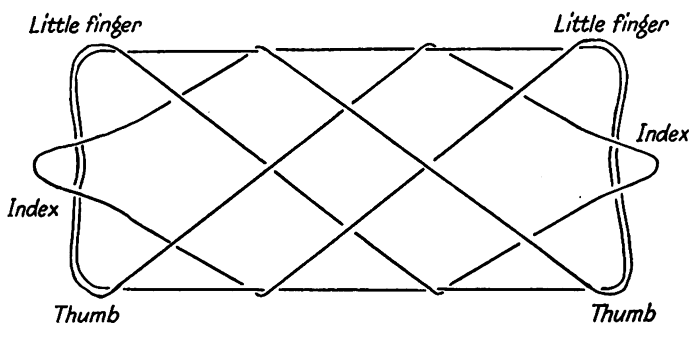


Fig. 5

RARA-NI-KULA, THE PARRAKEETS' PLAYGROUND.

V. Vale-ni-kula, the Parrakeets' Cage.

(1) Make the *Rara-ni-kula* figure and straighten the fingers. (2) From below pass the right index under the two palmar strings of the left hand and carry them back to form a double loop on the right index; do the same with the left index and the right palmar strings. (3) Incline the fingers of both hands towards one another and the cage is made.

VI. Vonu, the Turtle.

(1) Make the *Vale-ni-kula* figure. (2) Navaho the single proximal index loop on each hand over the double and distal loop. (3) Bend the index fingers downwards and hook them over the navahoed single strings that run from back to front of the figure, the right index taking the string on the right, the left index that on the left. Pull these strings outwards with the indices, slipping off at the same time the double index loops. Tauten all the loops as much as possible and equalize the size of the thumb and little finger loops. (4) Slipping all loops to the tips of the respective fingers, lay the figure upon a table, withdrawing the fingers from the loops, as carefully as possible.

A very fair representation of a turtle is the result, the index loops standing for the head and tail respectively, and the double loops for the two pairs of flippers. Two other figures may be made in continuation, but space does not permit of their description.

To anyone familiar with the cat's cradle as played in England, two outstanding differences in the working of these South Sea figures will be noticed. In the former the initial position results in two strings crossing the back of each hand in addition to one palmar string, while the co-operation of two players is necessary; in the latter only the palmar string is required, and the moves are made by one person only. These characteristics have been used to distinguish two main divisions, named Asiatic and Oceanic respectively—geographic terms none too happy, for the Oceanic type of game is common throughout the world except in Europe and Asia;

Africans, American Indians and Eskimos have games with typical Oceanic characteristics equally with the islanders of the Pacific.

Although a new branch of ethnological science barely a quarter of a century old, the literature devoted to it is already voluminous, and not a tithe of what it is likely to become a few years hence when the collections now being made in many parts of the world are published. Until then it will not be possible to make full use of the facts already accumulated for the tracing of the relationships and migrations of peoples. For example, till two years ago very few games had been collected from Polynesia, except New Zealand. Since then many blanks have been filled up, and in two recent publications scores of figures from Fiji, the Tongan and Samoan groups, and from the Society and Marquesas Islands, have been recorded; these throw much light on the relationships of the islanders, and give assurance of most valuable results when further work amplifies our knowledge and links up the games of these island groups with those of others of which we know little or nothing at present.

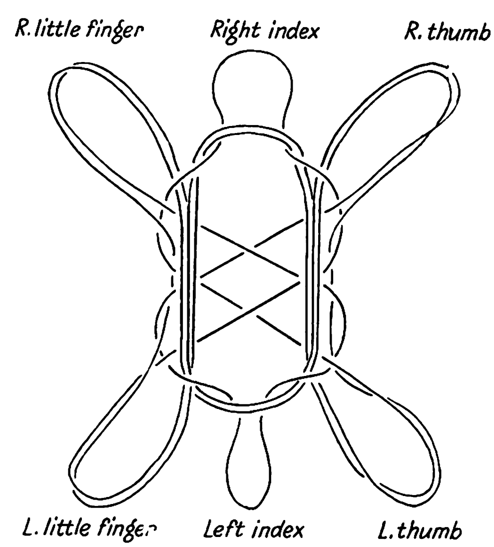


FIG. 6.
VONU, THE TURTLE.

There can be no reasonable doubt that string games had their beginning in the necessity for devising some means of amusement among people so situated as to environment and culture as to have much idle time on their hands. Notably must this cause have operated in the case of the Eskimos, whose string figures are by far the most intricate of any hitherto recorded. A curious peculiarity in their designs is that a large proportion are asymmetric, as, for example, their "Two Ptarmigan," "Dog on a Leash," "Wolverine," and "Fox and the Whale," the last being by far the most involved and difficult figure I have ever come across. Such are much harder to evolve than the bilaterally symmetric patterns almost universal in other regions. It is a safe generalization to say that wherever spinning, weaving and the kindred arts are unknown or little developed, the women and children have resort to this pastime to kill time. Wherever civilization is of old standing, that is, wherever agriculture and the industrial arts are highly advanced, the women folk in general have many more interests in life than their sisters among savage races, and little leisure for unproductive pastimes. Hence we find string figures few and comparatively uninteresting in Europe and Asia, where indeed one game, the original cat's cradle, is alone known to the vast majority of the population. It is by no means improbable, however, that our ancestors of the Stone and Bronze Ages beguiled the tedium of long winter evenings with the working of other string figures, playing doubtless with strings made from the sinews of wild animals, for two or three curious survivals linger on in Scotland and Ireland.

So far as we can judge, the true cat's cradle is of Asiatic—probably Chinese—origin. It seems to have passed westward from China in mediaeval times along the great trade routes to Europe.

In most localities where the Oceanic figures are woven, many are made to the accompaniment of chants, descriptive of the figures represented or of the stories they illustrate. In Polynesia some have mythological references, and it appears as if these were mnemonic aids in the transmission of the stories, like the *quipus* of American Indians. Others again have been pressed into the service of superstition and magic rites, as among certain New Guinea tribes where string figures are made at the yam-planting season and strewn on the ground to ensure that the yams will learn to twine properly. Similarly, some Eskimos weave figures when the sun is going south in the fall, to catch it in the meshes and retard its disappearance. Among another tribe boys may not play these games, for in later life their fingers might become entangled in the harpoon line. Only when they grow up and acquire skill in hunting are they allowed to play. Two hunters who had lost fingers by being nipped in the sealing line were believed to have played the forbidden game when boys. But these are exceptions, and for the vast majority of the figures, their invention has been due to a desire to escape the ennui of long days or evenings with little to occupy the mind or the fingers.

Their intricate designs also furnish the young folk with a delightful amusement that keeps them quiet and out of mischief for hours at a time. In the

outlying villages of many South Seas islands, the children may often be seen carrying loops of string, or ribbons torn from fibrous leaves, hung around their necks, ready to pit their skill against playmates in the weaving of figures.

In former days interest was far greater and more serious, to judge from the character of the chants which often accompany the progress of the game; many are far removed indeed from the jingles that children would invent. For example, in Fiji the women, while weaving the Tambua or Whale-tooth figure, sing the following words in a haunting cadence:—

"My whale's tooth, alas! alas!
Turn it round; alas! alas!
This whale's tooth is not a real one.

Come along and look at it.
Take the whale's tooth string and untie it,
And loosen the small cowry's cord."

And again, when forming the figure of Lulu, the Owl, the words which they chant embody a pretty conceit:

"The Owl soars on high;
The rat shakes in fear of death
In the long grass."

Space forbids further amplification of this theme, but I trust that what I have written may whet the appetite of many readers to learn more of this subject if only as a pastime and apart from serious study. At the same time I wish to stress the great importance to ethnological progress of the collection before it is too late, of all the figures that survive among indigenous populations—particularly do we require further information from Africa, Madagascar, the hill tribes of India and Indo-China, and from the aborigines of Australia and South America.

New Vitamin Products.

FOLLOWING our report last month of the latest work on Vitamin D, we have received from the British Drug Houses Ltd. some account of their new products which embody this essential food element. Before the discovery that this vitamin could be manufactured from a sterol, it had been generally accepted that vitamins were obtainable only from certain natural sources and in minute variable quantities. Fortunately the British Drug Houses were in a position to adapt this discovery at once to a commercial scale, as ergosterol was already being made in their laboratories. The irradiation was carried out under the supervision of trained technologists, and the therapeutic value of the resulting product (Vitamin D), available under the name Radiostol, is already established. Foodstuffs of every kind are lamentably deficient in Vitamin D, the supply being confined almost entirely to milk and butter, and even these in the winter months contain very little. In consequence an extension of the diet cannot make good the deficiency, and the fact that this vitamin is now available in ample quantities in such standardized products as Radiostol, Radiostoleum, and Radio-malt, is therefore an advance of the utmost importance. Radiostol is issued as a sweetmeat pellet and recommended in the treatment of specific cases of rickets, while Radiostoleum is stated to possess at least twenty times the vitamin content of the finest cod liver oil.

Correspondence.

ELECTRIC HEATING FOR CROPS.

To the Editor of DISCOVERY.

SIR,

I have just been perusing with much interest the article which appeared lately in your columns under the above title, dealing with the electric heating of the soil for market-garden crop purposes. You describe this as a Swedish development. However, your readers may be interested to hear that the practice apparently first originated in Norway, where Hjalmar Olsen is responsible for it. Your article is, of course, correct in that a greater use of this process is being made in Sweden than elsewhere. From the latest reports which I have received, I understand that the demand in the neighbourhood of Stockholm for this purpose is now about five thousand kilowatts. As this heating is switched on by an automatic clock at midnight and off at six a.m., it is a most welcome load from the point of view of electricity generating stations, who are thus enabled to provide the current at a price at which it pays the market gardener to consume it. Incidentally, there was a trifling slip in your quotation of the price, which was stated to be ½*d.* per kilowatt: it should, of course, be per kilowatt-hour, or per unit.

It may be of interest to you to know that for a considerable time past I have had a similar installation in my own garden, so that this country can at any rate claim that it is not behind hand in testing the process. The main value of the system is for obtaining early crops, more particularly in the cold months. However, I have got my gardener very enthusiastic and he carried on with this work throughout last spring and the early months of the summer with melons. The result was that he obtained an excellent crop, whilst my neighbours for many miles around were unable to obtain anything of the sort, because of the wet and cold weather.

It seems to me that the gardener and the farmer have a very bad time in their fight against nature. We have experienced trouble this year because, owing to the warmth of the electrically-heated soil, we hatched out slugs which ate the early lettuce. Now we know this, we shall be able to avoid it in future by seeing that earth which is going to be electrically-heated is first sterilized.

Yours truly,
R. BORLASE MATTHEWS.

Greater Felcourt, East Grinstead.

Mosquito Control in Canada.

By Dan McCowan.
Naturalist at Banff, Alberta.

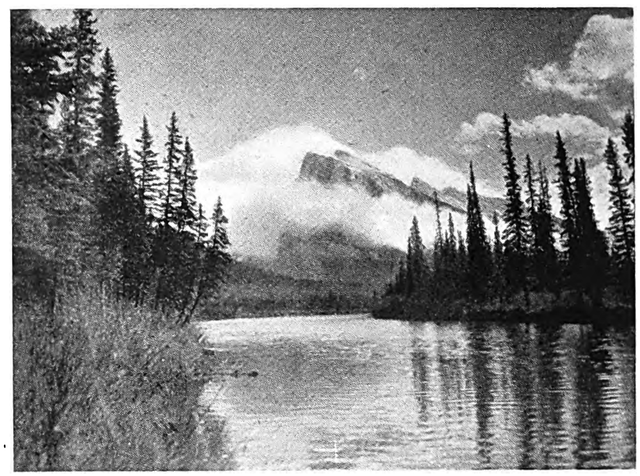
War on the mosquito in a Canadian holiday resort has revealed new details in the insect's life-history. Larvae may hatch from seven-year-old eggs, but it is comforting to learn that the taste for blood is an acquired one.

" Oh, the skeeter he fly high.
Oh, the skeeter he fly low "—

but not in the valley of the Bow, at Banff. For there the National Park authorities have now effectively put an end to the activities of the mosquito, and in so doing have made Canada's premier playground a pleasant tarrying place for the lover of outdoors. To bring about this desirable condition proved no light task. The valley is thickly wooded; there are countless depressions capable of containing snow, flood, and rain water. The entire area selected for treatment comprised some fourteen square miles of incult land, the whole intersected by rivers and brooks, and dotted with a profusion of small lakes. Yet even in such an ideal breeding ground as this, it has been clearly demonstrated that mosquito control is entirely practicable and can be made an unqualified success.

It is, of course, well known that oil is " bad medicine " to mosquito larvae, but experiment showed that special properties are needed. Mosquito larvae are hatched in stagnant water, and on coming to life are obliged to resort frequently to the surface in order to breathe. A thin film of oil spread upon pools and ponds prevents the " wrigglers " from reaching air, and they are thus destroyed. The preliminary tests were made with various kinds of oil. Coal oil and ordinary crude oil, being comparatively inexpensive, found favour at first. In order to function properly, however, it was essential that the oil film remain unbroken for from three to six hours, at the end of which time the entire brood present would invariably be destroyed. But little catspaws of wind and occasional showers of rain easily ruptured and perforated the film of ordinary oil, rendering the operation futile and necessitating the use of much more labour and material. In course of time a special blend of crude oils was obtained, which, while inexpensive, possessed unusual tenacity and was thus eminently adapted for this purpose.

"BAD MEDICINE" FOR THE MOSQUITO.
The oil used to kill the larvae is conveyed in drums to the filling stations of the area under treatment, by means of canoes.



THE VALLEY OF THE BOW.

During the spring and early summer months it was found necessary to give still waters and swampy areas from two to four applications of oil. The fluid was either sprayed from portable tanks similar to those used in fruit spraying, or else simply sprinkled by means of an ordinary watering-can. Metal drums of forty-five gallons capacity were transported in trucks and boats to convenient points throughout the territory, these serving as filling stations for the distribution of oil to the sprinklers. Normally, from one-third to one-half gallon of oil per acre was necessary for each application, the total quantity used being approximately two thousand gallons.

It must not be supposed, however, that the war against these obnoxious insects is entirely waged on the swamps. Highly skilled entomologists, working patiently in laboratories, have devoted much time and thought to mosquito control problems and, incidentally, have brought to light many curious facts concerning the life-history of the mosquito. For instance, it is now known that the life of an adult of the species common to the prairies and boreal regions of Canada may extend over a period of six weeks; that the female lays from eighty to one hundred eggs; that the eggs remain fertile for over seven years, and may possibly be capable of producing larvae at the expiration of a much longer term; that unless the eggs have been frozen, no larvae may be expected from them. It is also interesting to learn that mosquitoes are to be found in the very Far North. Some consolation, too, may be found in learning that normally the mosquito is a vegetarian, and that the taste for blood is a perverted one.

Is mosquito control an expensive operation? Taking all things into consideration, it is not. The cost of the oil is approximately a shilling per gallon. The work at Banff was carried on by students who are "earning their way" through western universities and colleges, and who made use of their holidays in this fashion. The benefits resulting from the operation are incalculable. Tens of thousands of tourists now annually pass joyous days and restful nights in the greenwood camps of the Canadian Rockies, undisturbed by the shrill pipes and pointed lances of the tormenting mosquito.

SPRAYING IN PROGRESS.

The Problem of Abnormal Audibility.

By C. Britton, M.Sc.

Gunfire heard in England during the war was frequently inaudible behind the lines in France. Ten years later research on the problem is still in progress, although a satisfactory explanation is now in sight.

It has been known for some centuries that a very loud sound heard at a great distance from the place of origin may be inaudible at a point nearer the source. Public attention was drawn to this phenomenon during the war. The sound of the gunfire in Flanders was not infrequently heard very clearly on still nights in London, but was not heard at places some twenty or thirty miles behind the firing line.

It was in somewhat similar circumstances, during the wars with the Dutch, that Samuel Pepys noted the phenomenon on the 4th June, 1666. "It is a miraculous thing," he writes, "that we all Friday and Saturday and yesterday did hear everywhere most plainly the guns go off, and yet at Deale and Dover, to last night, they did not hear one word of a fight, nor think they heard one gun." In fact, Governor Strowd of Dover Castle plainly said that the Londoners were mistaken in the sounds altogether and what they had heard was distant thunder. Pepys, however, adds that "it makes room for a great dispute in philosophy, how we should hear it and they not, the same wind that brought it to us being the same that should bring it to them; but so it is." Another interesting early record has recently come to light. The observation was made by Sir Philip Skippon at Wrentham in Suffolk, and he writes under date 7th June, 1673, "An Engagement between ye English and Dutch. Ye noise whereof was heard in Norff. and Lincolnshire, and at Cambridge and Bury. Yet wee about Sowold and Lestoffe could heare nothing, though ye wind was N.E., as favourable to ye Suffolke as to ye Norff. Shore." This "great dispute in philosophy" has remained a dispute until within the last few years, when new discoveries and hypotheses concerning the

physical state of the upper air have suggested a possible solution.

The vehicle of the sound wave is the atmosphere. The vibrations of the sounding body are transmitted to the air, through which they travel until they reach the ear. When they impinge upon the auditory mechanism of the ear we experience a sensation and we say we hear the sound. The farther we go from the source of the sound the less intense the sensation becomes, and finally, when we are far enough away, we fail to hear the sound at all. Theoretically speaking, if there were no loss of energy, the intensity of the sound would decrease inversely as the square of the distance of the observer from the source, but in actual practice, variations in the atmospheric conditions play a very important part in modifying the exact application of this law. It is, nevertheless, true that if we remove ourselves far enough away from the origin of the sound we shall no longer hear it. It seems very surprising, therefore, that if we move, say, twice as far away we may hear the sound again. Yet such apparent anomalies have been observed and studied.

The Silvertown Explosion.

It is, of course, obvious that only a very loud sound stands any chance of being heard at 100 miles from its origin, especially if the listener is not expecting the arrival of the sound. Unfortunately, suitable loud sounds generally occur involuntarily, and there is no opportunity for advising listeners to be on the *qui vive* and to make proper arrangements for making the necessary timing observations. The disastrous explosion at Silvertown during the war gave a sufficiently intense sound wave for the distribution of audibility to be studied. In an irregular area of roughly thirty miles radius around Silvertown the sound of the explosion was audible. This area may be called the region of normal audibility. Around this area was a ring of inaudibility in which no sound was heard. This ring was roughly forty miles wide and included, on its north side, the towns of Ipswich, Cambridge, Oakham, and Uppingham. Beyond this again, we come to an area where the sound was distinctly heard. This zone we may denote as the region of abnormal audibility. In this example, this region extended to a distance of about 120 miles from the site of the explosion, and included the towns of Norwich, Nottingham, and Lincoln.

The explosion in this case was quite accidental, but efforts have been made in recent years to give the subject more detailed study by arranging for the detonation of large quantities of surplus explosive at predetermined instants. A corps of observers were notified of these proposed times of explosion, and they kept careful watch for the advent of the sound wave, noting, if they heard it, the exact instant of its arrival. In this way the areas of silence and abnormal audibility could be mapped out and the times of the passage of the sound studied. A number of such explosions have taken place at Oldebroek in Holland and at La Courtine in France. The results obtained from the three main explosions at La Courtine, which took place on 15th, 23rd and 25th May, 1924, have been collated and discussed by Maurain. In each case similar phenomena were noticed to those disclosed by the examination of the Silvertown explosion. Around La Courtine was a region of normal audibility. Surrounding this area was a zone of silence and outside this, again, one or more areas of abnormal audibility. As a result of these investigations there can be no doubt that the sound of a large explosion can be heard at a great distance, and that the sound wave has not travelled directly over the surface of the earth from source to observer in the normal way. The only feasible explanation seems to be that the sound wave reaches the observer by an overhead route.

In discussing the problem it is necessary to draw attention to an important fact concerning the transmission of sound in air, namely, the dependence of the velocity of propagation upon the temperature of the air. Sound travels faster if the temperature of the air rises, and slower if it falls, the variation being 1.1 feet per second for each degree Fahrenheit. Thus on a cold winter day when the air temperatire is 30° F., the velocity of sound is about 66 feet per second slower than on a hot summer day when the temperature is 90° F. We shall find that this property is of great importance when we come to consider a possible solution of the problem, and it is therefore necessary to consider in some detail what we know of the condition of the atmosphere as regards temperature.

Atmospheric Conditions.

It must be borne in mind that our knowledge of the conditions obtaining in the atmosphere at even moderate heights is a recent acquisition. It has long been known that the temperature of the atmosphere decreased with increasing altitude, and the permanent snow at the summits of high mountains was a visible reminder of this fact. The work of the early balloonists—Gay Lussac, Green, Rush, and Glaisher—confirmed this. Their thermometric observations, carried out to as great a height as their manned balloons would take them, showed that, in general, the temperature continued to fall up to the greatest

altitudes attainable. There appeared to be no reason to doubt that the temperature would continue to fall until in the very upper limits of the atmosphere the degree of cold attained gradually approached the absolute zero. True, a faint suspicion that this might not be the case came in 1862, when Glaisher in an exceptionally high ascent in a balloon found that the rate of fall of temperature with height appeared to decrease near the maximum altitude of the ascent, but this was merely an isolated instance which might be attributed to some irregularity. Unfortunately, a height of 30,000 feet is about the utmost which can be attained in a manned balloon, and if the temperature conditions above this height were to be studied at all, some other way would have to be tried.

Experiments with Balloons.

It was in 1893 that Hermite and Besançon developed the method of releasing small free balloons carrying self-recording instruments. This valuable method has been improved and extended of recent years, and the pioneer work of the late W. H. Dines in this field is well known to meteorologists. These small balloons are often able to attain great heights. The instrument they carry is specially designed to register continuously the changes of temperature and height, and is wonderfully light and compact. Ultimately the balloon bursts or develops a small leak. It descends to the ground with its instrument attached, on which a small label asks the finder to carry out certain instructions. When the instrument is finally returned to the investigator, the record, which is made by fine pens upon a small silvered plate, is deciphered, and tables are drawn up showing the temperatures experienced at various heights. This method of investigation has given satisfactory results in practice, and ascents have been made in many countries under a scheme of international co-operation. As a result of these researches a remarkable fact about the state of the upper air emerged. It was discovered that the temperature of the air did not continuously fall off with increasing height, but that a stage was reached when the temperature ceased to fall and thereafter remained almost stationary. The height at which this remarkable transition occurs has been found to vary with the latitude, with the season of the year, and with the type of pressure distribution prevailing at the time. In general, we may summarize by saying that these researches introduce us to the picture of an atmosphere divided into two well-defined regions. The lower layer is characterized by the fact that, in general, the temperature decreases with the height. The upper layer possesses the characteristic that there is practically no change of temperature in the vertical direction. Teisserenc de Bort coined the term "stratosphere" to denote this newly-discovered upper layer, and the word "troposphere" has been invented for the lower layer. The height at which the transition takes place is called the "tropopause." In these latitudes the height of the tropopause is about seven miles. Over the equator it is higher than this, and over the poles, lower. Thus entry into the stratosphere is likely to be denied to a manned balloon in this country save upon very exceptional occasions.

The question naturally arises, to what altitude does the stratosphere extend. Until the recent investigations of Professor Lindemann and Dr. Dobson, in 1922, there seemed no reason to think otherwise than that it extended to the upper limits of the atmosphere. The greatest heights that had been attained by the free balloons had given no indications of any other marked change in the conditions of the atmosphere, and these researches gave us information up to about fifteen miles and, exceptionally, to over twenty miles. The difficulties in the way of direct investigation are very great, and the attainment of any height greater than twenty-five miles seemed impossible by any known method. Lindemann and Dobson, however, had been studying meteors, or shooting stars, phenomena which take place in the high atmosphere, and as a result of their investigations they were led to some remarkable conclusions as to the physical state of the atmosphere in regions forty miles above the ground. They examined observations of the heights, trajectories, and speeds of several thousands of meteors, and they concluded that the temperature of the air at this great altitude is considerably higher than that prevailing in the stratosphere. They consider that something approaching 100° F. is the temperature in these regions, a figure somewhat higher than the average for the surface.

Sound and Temperature.

This unexpected result leads us to the contemplation of a third atmospheric region occupying a position above the stratosphere, and for which the name "empyrean" has been suggested. F. J. W. Whipple has pointed out that the existence of the empyrean opens the way to a possible explanation of the anomalous audibility of loud sounds at great distances. The basis of this explanation is the refraction which a ray of sound undergoes when passing from air of a certain temperature into air of a different temperature. The analogous phenomenon in the case of a ray of light is common knowledge. When a light ray enters a medium in which the velocity of light is different to

the velocity in air, the ray undergoes bending, or refraction. A ray of light passing from air into water, for instance, is bent sharply away from the surface because the velocity of light in water is slower than in air. The well-known effect of this refraction is to make objects appear to be less deep in a pool than they really are. So in the case of rays of sound. A sound ray in the free atmosphere, however, introduces us to the complication that the air temperature, in the lowest layers at any rate, continuously falls as the ray goes upwards. As an example, let us consider an explosion which takes place at some point on the ground. Sound waves proceed through the air in all directions from the point. Some sound rays proceed horizontally over the surface, others rise nearly vertically, and others rise at intermediate angles. Suppose we confine our attention to a ray of sound which rises from the explosion and is inclined at an angle of, say, 20° with the ground. Now, if the temperature of the air remained constant throughout, then this ray would proceed always in the same straight line and would thus always be at 20° to the ground. But as the temperature of the troposphere is continually falling as the ray goes higher, the ray undergoes refraction and is bent slightly upwards. This upward bending goes on as long as the temperature continues to fall, that is to say, until a height of about seven miles has been attained and the stratosphere has been reached. On meeting these new temperature conditions our ray is now inclined at an angle to the ground which is steeper than the 20° at which it started. What is its experience in the stratosphere? In this region there is practically no temperature change in the vertical direction. This means that there is no further refraction of the sound ray, and it carries on in a straight line throughout the stratosphere.

Maximum Height.

At a height of about 30 miles the ray begins to reach the region of the empyrean and commences to experience temperature changes again. Here, however, the changes are in the reverse direction to those experienced in the lowest layer, the troposphere. The temperature is now increasing with height and the ray is being bent downwards. If circumstances are favourable, this downward bending may continue sufficiently long to enable the ray to enter the stratosphere a second time. If this happens it goes through the original cycle of changes as it passes down through the stratosphere and troposphere, but in the reverse order. If the ray finally reaches the ground we shall have a region of abnormal audibility. The total effect of all the original rays from the sound of the exploson will be to give us, outside the normal audibility zone, a region of silence, because here the rays are passing high overhead. Beyond the zone of silence we shall have the area of abnormal audibility in which the rays have been refracted downwards on to the ground by favourable temperature conditions in the empyrean. It is clear that sufficient sound energy to carry the rays through the long flights required by this explanation can only be obtained from very loud sounds and explosions.

Other Theories.

Other possible explanations of these areas of silence and abnormal audibility may be alluded to briefly. Before the existence of the empyrean was suspected, it was very difficult to explain the facts upon meteorological grounds alone. If we had a wind in the upper air in a reverse direction to that near the ground, such a wind distribution might be adequate to explain the phenomenon, provided the area of abnormal audibility were always to be found to the windward of the explosion. This, however, is not so; the abnormal zone is sometimes to leeward, and in one of the La Courtine explosions this zone formed almost a complete ring. No reasonable theory of wind distribution seems adequate to fit such cases as these.

It has been suggested that the ground may be the vehicle of the sound which is heard in these regions of abnormal audibility. For example, on a night during the war when the gunfire on the western front was very clearly audible upon a chalk hill near London, the sounds were quite inaudible upon a near-by sandstone ridge of equal height. This effect was probably due to atmospheric conditions. The difficulty in assuming the ground to be the vehicle of the sound wave is found in the existence of the zones of silence. This zone is always present when areas of abnormal audibility exist, wherever the explosion itself has taken place, and the presence of these silent zones seems inexplicable on any hypothesis of transmission through the ground.

F. J. W. Whipple has suggested that the sounds due to heavy gunfire might be of sufficient magnitude to enable these areas of abnormal audibility to be detected, and he was successful on one occasion at Grantham in hearing the sounds of a large gun which was being fired at Shoeburyness. Further research is being conducted upon these lines, and it is hoped that the results will cast light upon the acoustic phenomenon itself and upon the state of the high atmosphere. These results will certainly be awaited with great interest.

The Secret of the Cuckoo.

By Oliver G. Pike, F.Z.S.

For some years past the author has been collecting evidence in support of a new theory concerning the habits of the cuckoo. Specific data advanced from observation are illustrated by a remarkable series of photographs.

An enormous amount of controversy has raged round the English cuckoo. Some students say that when the cuckoo deposits her egg in the nest of the fosterer she does it with her beak, while others hold that she always lays her egg into the nest in the normal manner, like any other bird. There are those who compromise and suggest that sometimes she lays her egg, and on other occasions places it there with her beak. A very small minority, who need not be taken seriously, insist that no cuckoo ever has laid direct into a nest.

For about two thousand years past, or as long as we have any record of the cuckoo, the generally accepted theory has been that she first laid her egg upon the ground, picked it up in her beak, and carried it to the selected nest. Mr. Edgar Chance's recent book, "The Cuckoo's Secret," therefore dropped a bomb-shell among nature-lovers, for it proved conclusively that the cuckoos under his observation laid their eggs direct into the nests. Notwithstanding he met with much opposition from those who disliked the old theory upset. Some asked how the cuckoo laid her egg into a fragile nest like that of the reed warbler? Others mentioned instances of cuckoos' eggs being found in the nests of the wren and chiffchaff—two small nests that are domed over with a small entrance at the side, far too small for the cuckoo to enter. A few of the more violent critics said that it would be necessary to photograph every female cuckoo in England if the new theory was to be proved, for some might lay into the nest, while others would carry their eggs to deposit them with their beaks.

CUCKOO IN MEADOW PIPIT'S NEST.

The bird is holding in her beak a pipit's egg previously removed from the nest, into which she proceeds to lay her own egg.

Copyright photograph by O. G. Pike and E. P. Chance.

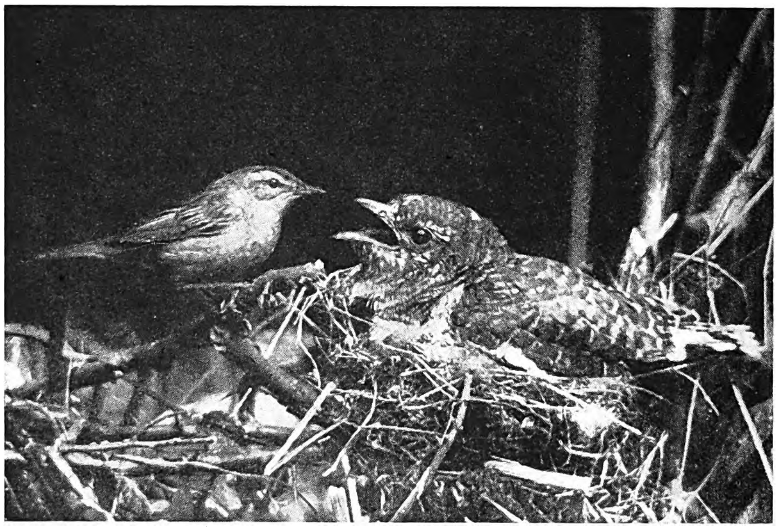
Following the publication of "The Cuckoo's Secret" I worked in conjunction with the author, and together we produced a cinema film which proved beyond shadow of doubt that the cuckoos which we photographed laid their eggs into the nests, after first stealing one of the original eggs. A wonderful slow-motion film was obtained, which showed every detail of the cuckoo arriving, stealing the egg, and laying her egg in its place, afterwards flying off with the stolen egg which she retained in her beak while laying. A series of conclusive pictures was obtained at five different nests.

Since then others have watched various cuckoos, and some wonderful observations have been obtained. It has been found that whenever the watcher has had a clear view of the whole performance, on each occasion the cuckoo has been seen to lay direct into the nest. Observers have seen her way in the nests of the following birds:—

Tree pipit, meadow pipit, rock pipit, yellow hammer, pied wagtail, and reed warbler. I have seen a cuckoo flying round a hedge-sparrow's nest in which there were two eggs of the owner bird. I had a clear view of the cuckoo as she went to the nest, and there was definitely no egg in her beak. Less than ten seconds later, the nest contained one hedge-sparrow's egg, and one deposited there by the cuckoo. There was no doubt in my mind that she laid it. This rather imposing list contains most of the chief birds that the cuckoo uses as a fosterer, and it goes far to prove Mr. Chance's and my belief, that all cuckoos lay into the nest, and do not deposit the egg with the beak.

Some very careful naturalists have made observations where eggs of the cuckoo have been found in small domed nests. I have watched the cuckoo lay many times; I have been very near the bird on each occasion, and I have come to the conclusion that she would have very little difficulty in laying her egg into these nests by holding on to the sides with her claws, laying the egg into the entrance. It has been noticed that when eggs are found in such nests, the front or sides of each has been disturbed where the cuckoo evidently clung to the exterior. At some of these nests the cuckoo's egg has been found just outside, which goes to prove that when she attempted to lay the egg through the entrance, she failed to do so, and it rolled down and remained outside. If she had been placing it there with her beak and had happened to drop it, she would not have been so foolish as to leave it lying outside, but would have picked it up and made another attempt.

On one occasion we surrounded a pipit's nest with thorns and twigs, leaving a little hole at the entrance through which the cuckoo could place her egg with her beak, but we made it so that the bird herself would have extreme difficulty to pass through the entrance. It was interesting to watch what happened when the cuckoo arrived. She first went to the entrance and found it was not possible to pass that way. In front was a flat space on which she could have easily laid her egg, to pick it up afterwards if she so desired. But the bird had no intention of doing this. She wished to deposit her egg in that nest, and the only manner in which she knew how to accomplish this, was to lay it. She examined the gorse bush under which the pipit's nest was concealed, then set about performing her allotted task. She settled on top of the bush, and putting her head down, fought her way through the thorns. She lost several feathers as she went down, but reached the nest. I watched her first take one of the pipit's eggs, then she moved her body on to the nest, laid her egg, and returned the way she came, through the body of the bush.



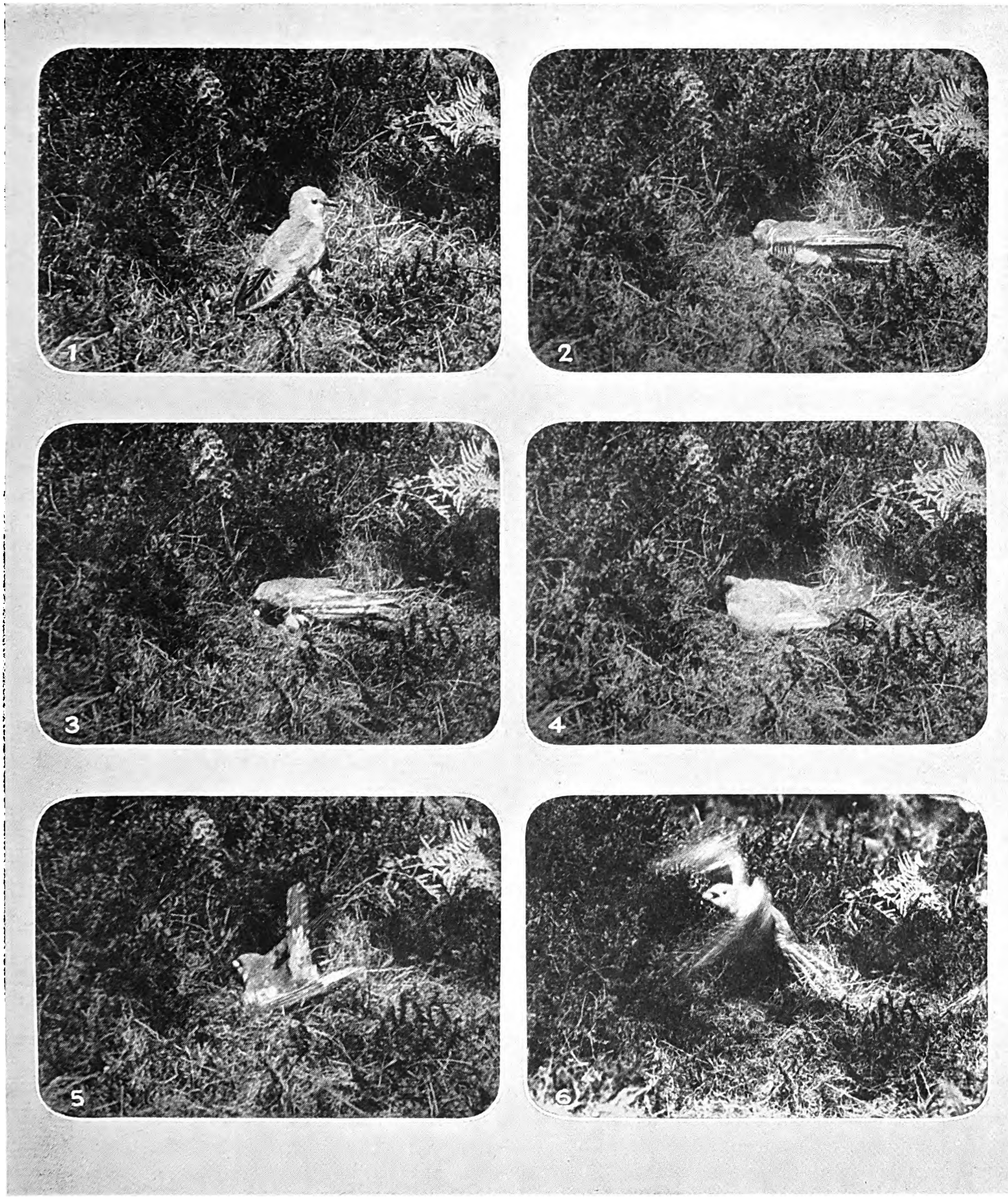
A SEDGE WARBLER AND HER LARGE INFANT.

The ten-day-old cuckoo is already too large for the nest of its foster-parent, whose relative size is here clearly brought out. *Photograph by Oliver Pike.*

A cuckoo lays her eggs every alternate day during the laying period. On her laying day, she first takes up her position on a comfortable perch, either a fence, post, or branch. Here she remains very still for a period varying from one to eight hours, and this corresponds to the time spent by other birds which sit on their nests before laying. This discovery alone goes far to prove the modern theory. When she is ready to lay, she leaves her perch and glides to the nest previously located. When she reaches it no time is lost. First she takes out one of the original eggs, quickly moves her body on to the nest, and lays her own egg in its place, the whole performance seldom lasting more than ten seconds. She then flies off with the stolen egg, settles on a convenient perch, throws her head back, and devours the egg. She swallows it rather ravenously, for if she has spent some hours on her perch before laying, this is the first meal tasted for a long time.

When the cuckoo has laid her egg she does not forget all about it. The majority of birds lay a second clutch after their first has been taken. The normal number of eggs laid by a cuckoo would be about five, but if her eggs are taken from the nests of the fosterers, then she continues to lay, and one cuckoo has been known to lay twenty-five eggs in a season. She is not satisfied until she finds that her scattered brood is well on its way to being reared by the various fosterers. When success is assured, she and her mate leave the country.

The story of the young cuckoo is one of the most fascinating in the annals of natural history. The period of the incubation of the cuckoo's egg is thirteen days. When the youngster first hatches out it is blind, and lying at the bottom of the nest it appears as a little lump of almost black flesh. On the first day it takes no notice of its nest companions, or other eggs in the nest, but on the evening of the second, or



HOW THE CUCKOO LAYS HER EGG IN A FOSTERER'S NEST.

A series of photographs enlarged from a cinema film showing a cuckoo arriving at a meadow pipit's nest to lay her egg. (1) The cuckoo arrives. (2) She moves towards the nest. (3) She steals a pipit's egg. (4) Showing the actual moment of laying, with her body over the nest. (5) Commencing to spring from the nest the moment after laying, still holding the stolen egg in her beak. (6) Flying away with the stolen egg. From the moment of approach in No. 1 to the time of flying away in 6 only ten seconds passed.

Copyright photographs by O. G. Pike and E. P. Chance.

the morning of the third day, this helpless looking infant becomes imbued with wonderful strength and instinct. The remaining eggs, or perhaps young in the nest, represent future rivals for food, and this the cuckoo cannot tolerate. So the youngster empties the nest of all other eggs or young. If there are eggs his task is fairly easy for he gets one upon his back, stands up, and rolls each over the side. With young his task is more difficult, but he quickly accomplishes it.

Ejecting a Nest Companion.

I have often tested the strength of young cuckoos with birds very much larger and stronger than themselves. At one nest of the reed warbler that I desired to film, I found that the young cuckoo had forestalled me, and the three young warblers were lying dead under the nest. I found a young sedge warbler in a neighbouring nest, which had feathers on its body, was twice the size of the cuckoo, and was able to see what was taking place. The cuckoo was still blind, but directly I placed the warbler in the nest a most wonderful struggle began. As I watched I could see that it could have but one ending. The cuckoo showed the most amazing powers of strength. It worked down in the nest until its companion was on its back, then, gripping the sides of the nest with its feet, it used the wonderful muscles on its legs and slowly but surely raised its burden. When it appeared to have reached the extent of its stretching powers, it opened the small fleshy arms that would someday be two fine wings, and began to work these up and down. It also jerked its body upwards with violent movements, with the result that the warbler was flung ignominiously over the side of the nest. The youngster now tumbled to the bottom of the nest, worked round to see that there were no more rivals present, then settled down to contentment and rest.

The young bird, now obtaining all the food, grows rapidly. Ten days later it is clothed in fine feathers, and is larger than the nest on which it tries to make itself comfortable. When it begins to fly, the foster-parents follow it about. The youngster will usually sit in fairly prominent positions, and occasionally utters a curious high-pitched note. This seems to have a wonderful effect. Other birds in the district may be carrying food to their own young. If they see the hungry cuckoo sitting there with its great beak wide open, or if they hear that querulous cry, they pause in their flight, and strange to say, hand their supplies to it, and perhaps will even return with further supplies! There was a record a few years ago of a cuckoo that was reared by a pair of hedge-sparrows being fed by five different species of birds.

At last the foster-parents leave their great overgrown baby, and then it seems to have some difficulty in finding insect food. While the other birds were bringing supplies, it was content to sit still, but now that it is left to its own resources it has the greatest difficulty in finding similar provisions. It becomes very hungry, and changes its diet to that of a vegetarian, devouring green stuff which it can find in plenty. The crops of twelve young cuckoos, which had been deserted by their foster-parents, were examined, and in each instance no trace of insect food was found. Eventually these youngsters, which are so cleverly able to adapt themselves to their surroundings, find where the insects are hidden, and go back to their usual food. Five, eight, or even ten weeks after their real parents, the adult cuckoos, leave the country, these youngsters launch out on a long journey, flying south, eventually to reach Africa where they spend the chief part of the year.

There is still much to be discovered about this interesting bird, but a word is necessary as regards those observers who say that they have seen cuckoos carrying their eggs in the beak. The cuckoo is a confirmed egg thief, and how do these observers know that the egg that is being carried has been laid by the bird? On her non-laying days I have watched the cuckoo take eggs from other nests, and carry them off, but as far as I know, no one has yet filmed the cuckoo in the act of placing her egg in a nest with her beak.

When we sum up all the evidence we cannot help asking whether the naturalists of the past have not made a great mistake, and been rather prone to follow in the footsteps of predecessors, accepting their statements without taking the trouble to investigate for themselves. In the light of modern discovery, observers of all kinds should start afresh, obliterating from their minds all previous theories. It is only by doing this that we shall be able to steal the cuckoo's secret from her, and prove a much debated problem.

Re-Creation of the Universe.

WHAT is described as an entirely new conception of the universe was announced last month by Dr. Robert A. Millikan, the famous American physicist. According to *The Times* report, the evidence shows tentatively that a building up process is going on to replace the tearing down process represented by radio-activity. New and more precise measurements of the cosmic rays than those hitherto made, show that these rays represent the precise amount of energy which should be emitted in the form of æther waves, when primordial positive and negative electrons unite to create helium and other light atoms such as oxygen.

YOUNG CUCKOO EJECTING ITS NEST COMPANION.

This series of photographs from a cinema film by Oliver Pike shows :—(1) The cuckoo gets underneath. (2) The struggle commences. (3) Having raised its rival, the cuckoo spreads its wings, preventing return to the nest. (4) Over the top. (5) Going. (6) Gone !

The Future of Sheep-Farming in Peru.

Professor Barker's Report.

A remarkable future for millions of undeveloped acres in Peru is predicted by Professor Barker, head of the Textiles Department of the University of Leeds, as a result of recent discoveries in sheep-breeding.

Experiences in sheep-breeding and wool growing through which Peru is now passing are likely to prove of world-wide importance, according to a report* which Professor A. F. Barker, of the University of Leeds, has prepared for the Peruvian Government. A good start has been made in the development of Peru as one of the great wool-producing countries of the world, and it is quite conceivable that within a decade the wool-clip of Peru may be quadrupled.

Attention was first directed towards the great possibilities of the developments just being inaugurated by Colonel Stordy, under the Peruvian Government, at a meeting held in Perth in 1920—the outcome of propaganda work undertaken by Professor Barker in collaboration with Professor Cossar Ewart of Edinburgh University. Prior to the present century the relationship of the wool-grower to the manufacturer was scarcely developed, the ultimate destination of the wool on the one hand and the breeds and types of sheep on the other being matters of which little or nothing was mutually known.

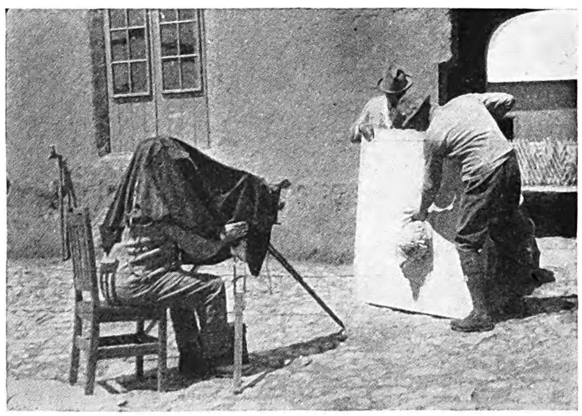


Fig. 1.
PHOTOGRAPHING SHEEP AT THE MODEL FARM.

On arrival in Peru, in 1926, Professor Barker was asked to report to the President not only on the Peruvian Government's experiments at Chuquibambilla, but also to tour some thirty million undeveloped acres in Southern Peru. He was conducted by Colonel Stordy, who has charge of the official experiments and had brought up the subject at the Perth meeting. After landing at Mollendo, Professor Barker was run up to Arequipa in Autocarille and "acclimatized" for several days before ascending to the higher altitudes. In this connexion, it is noted that at 12,000 feet and upwards the altitude appears to affect animals other than sheep—well-bred horses, for example, die off even if acclimatized in stages, whereas pedigree sheep may be taken straight up on the elevated table-lands with no perceptible ill-effect.

Before proceeding to tour the principal sheep-farming centres, the Professor inspected the Model Farm at Chuquibambilla, where photographs were taken of selected sheep (Fig. 1) which it was thought might throw light on the problems to be investigated. Many of the other remarkable photographs illustrating the report were also taken by Colonel Stordy, of which a few are here reproduced in *Discovery* by permission. The exhaustive nature of the report delayed its publication, but the survey it contains gives many details never previously available.

The prospects of sheep-breeding and wool growing in Peru are strikingly suggested in the survey of the present position with which the report first deals. Earlier statistics are necessarily incomplete, but they are nevertheless very illuminative; it appears, for example, that Peru has doubled its sheep population in a period of about five years.* Apart from the remarkable increase in numbers which the figures indicate, an important deduction concerns the change that has taken place in the weight of the various fleeces; this factor being of first-importance in the genetic aspect of sheep development. If, for example, the results of the experiments at Chuquibambilla should lead to the increasing of the weight of the

* "The Prospective Development of Peru as a Sheep-breeding and Wool-growing Country." By Professor A. F. Barker, M.Sc., illustrated with photographs by Colonel R. T. Stordy, C.B.E., D.S.O. (Leeds, 1927, English and Spanish Editions, £1 1s.).

	*Sheep Statistics.		Wool Production.	
Approx. dates	1920	1925	1920	1925
Peru	6,357,396	12,600,000	9,000,000	15,432,000
Chili	4,500,000	4,800,000	37,000,000	38,500,000
Argentine	43,000,000	30,267,591	237,000,000	279,392,000

Peruvian fleece from $1\frac{1}{4}$ lb. to 5 lb., Peru with its present flocks would produce from 60,000,000 to 70,000,000 lb. of wool per annum. It would then rank third among the South American wool-producing countries, and could hope soon to rival the output of South Africa.

At present, the weight of the fleece is obviously one of the defects of the Peruvian flocks, and the question will naturally arise as to whether an environment which is naturally producing $1\frac{1}{2}$ lb. of fleece can be constrained to produce, say, a 6 lb. fleece without sacrifice of quality. It is, however, now recognized that in stages Australia increased the average weight of its merino fleeces from approximately 4 lb. between 1825 and 1880 to 6 lb. from 1880 to 1900 and to 10 lb. from 1900 to 1925.

It is almost certainly true to say that what Australia has done by cross-breeding and selection, Peru also will be able to do by cross-breeding and careful utilization of its pasture-lands. But present purposes will best be served by candidly recognizing that the Peruvian fleece is exceedingly light, and that this factor must be carefully taken into account in all endeavours to improve and maintain the breed in both weight and quality. Along with the lightness of fleece, however, goes an extraordinarily good yield, the normal loss in scouring the best Peruvian wools often being under 40 per cent, so clean is the pasturage upon which the sheep feed. This excellent yield, along with a special fullness and felting quality, probably explains the liking which some wool-buyers have for native Peruvian wools. In appearance it is sometimes unattractive, but it "works up" much better than is anticipated.

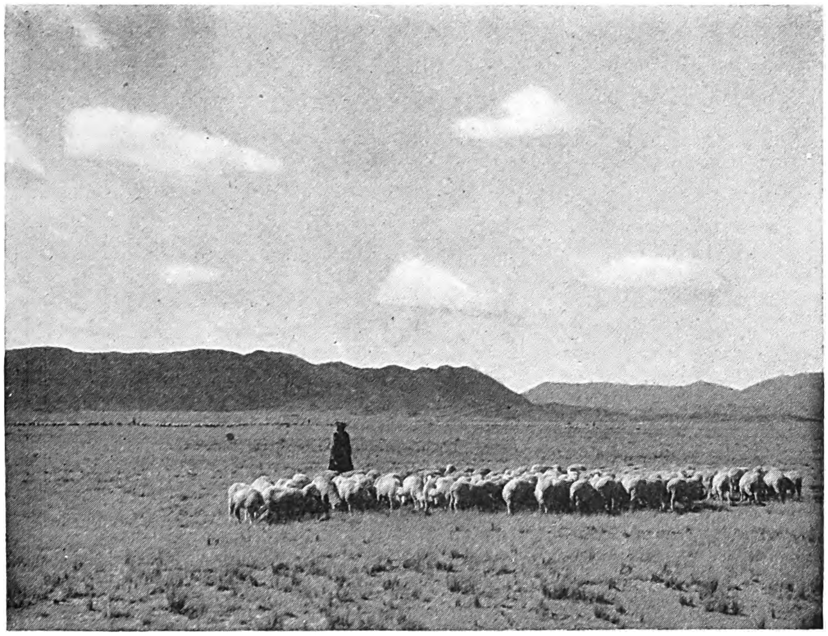


FIG. 2.
NATIVE "TENDED" FLOCKS OF SHEEP.
The irregular feeding which native conditions allow has a detrimental effect on the wool, a break in the staple of the wool being attributable to this cause.

The next section of the report deals in technical detail with the genetic aspects of the study of Peruvian sheep and wool, following which an interesting description is given of the Chuquibambilla Model Farm and of Colonel Stordy's work. As this summarizes the problems with which investigation is at present faced, and shows how they are being overcome, the remainder of our review may be devoted to it. The report, however, contains further sections on sheep-breeding and on the comparative manufacturing values of Peruvian and "improved" Peruvian wools, together with a summary of recommendations based upon the foregoing records. Numerous supplementary data are contained in valuable appendices.

It is pointed out that investigations of the sheep on the heights of the Andes in Southern Peru, and of their extraordinary characters suggests the possibility of introducing better race-characters and of evolving Peruvian sheep on to lines not incomparable with those of Australia and the Cape. This possibility must have been in the minds of the controllers of the destiny of Peru for some time, and it only needed the suggestion of a wool-shortage and dearer wool to bring a scheme for such a development within the range of practical politics. This scheme was formally inaugurated under President Leguia in 1920 when Colonel R. J. Stordy, who had had most useful experiences in East Africa, was appointed with the object of developing a model school upon the Andean heights at Chuquibambilla (12,900 feet). This was to take the lead in experimental work directed towards the evolution of the Peruvian sheep on to lines which would bring "Improved Peruvian Wool" up to the standard required by the European and American manufacturing industries. Some five years of experimentation have been sufficient to define both the possibilities and the lines of development of the

wonderful tract of some 20,000,000 acres of sheep country. Flocks of sheep "tended" by Indian women range without discrimination the tracts of grazing land (Fig. 2), being taken out in the morning and brought to the homestead in the evening—probably just at the time when they would feed the best—with the result that the wool-staple exactly reflects the seasonal feeding possibilities, too luscious at one time and not sufficient at another; this latter condition being represented by almost a disastrous break in the staple of wool. This break may be in part a breed characteristic, but is much more likely to be entirely due to the feeding conditions. Much poorer grazing land to the south of the South American Continent is fenced in, and with the extension of wire mesh fencing, Southern Peru may become one of the richest and best sheep rearing tracts of the world, carrying a sheep upon one to two acres without any fear of an impoverished feed resulting in such a break in the wool-staple.

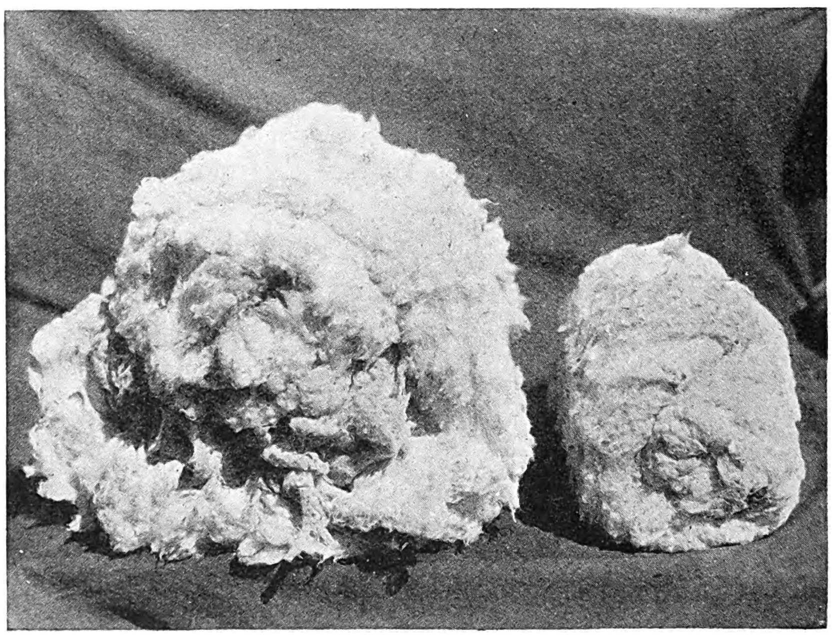


FIG. 3.
NATIVE FLEECE COMPARED WITH IMPROVED FLEECE.
The weight of the half-bred improved fleece is 5 lb. free from kemp, which compares with 1 lb. 6 oz. only of the kempy native fleece.

The rate of the growth of wool has never been clearly defined, but a series of locks sheared from a cross-bred lamb, as recorded in the University of Leeds, tends upon the whole to suggest a regular increase in length of staple. The weight of fleece naturally follows increase in depth of staple and density, and is well illustrated in Fig. 3, in which the native and half-bred improved fleeces are compared, the following being the particulars:—the weight of the half-bred improved fleece is 5 lb. (free from kemp), and that of the native fleece 1 lb. 6 oz. (kempy). The reason for this remarkable increase in weight of fleece is attributable to the larger skin area, to density and length, and to the better distribution of the wool on the body of the half-bred sheep as compared with the native. This is illustrated in Fig. 4. South American and New Zealand buyers of English Romney Marsh sheep have invariably paid the highest prices for the most fully-woolled sheep, and as this characteristic would appear to be entirely a race-character, there is no apparent reason why the well-woolled body should not be maintained in the Improved Peruvian flocks.

The improved shearing and getting-up of the wool naturally follow Colonel Stordy's organization and training of the Indians upon the farm. When inspected at work on the farmstead these men were found to be shearing well—the sheep do not present the "bloody mess" so frequently to be seen on Australian stations, as no attempt is made to shear into the hundreds a day.

With these actualities fully in view it is not surprising that Peru should feel strongly encouraged to go forward with this development. What it may ultimately mean will be realized if the present and prospective conditions of the Indian upon the heights be considered. At present these people—descendants from the inhabitants of the Inca Empire—live entirely a "self-contained" life. They build their huts of adobe bricks; plant their patches of sweet-potato; tend their sheep, shear the wool, spin the yarn, and weave the cloth for their garments (as is described in an interesting section of the report on Peruvian native industries). They neither desire to sell nor to buy anything. But the sheep only yield, say, 1¼ lb. of wool. Colonel Stordy's experiments show that if well-bred rams—or even half-bred rams—are introduced the fleece weight will be increased to from 3 to 5 lb. The Indians will then have wool to sell and money to spend, with effects on the conditions in Peru that can readily be imagined.

The quality of wool already produced suggests that the "Improved Peruvian Wool," when stabilized and produced in sufficient quantity, may well challenge comparison with the wools from Australasia and the Cape as sold at the London Wool Sales. Although wool will always be dominant, yet the way in which Down sheep thrive at the Model Farm suggests that a good type and weight of carcase may be produced, and as the farm is close to the railway which leads direct to the port of Mollendo, a frozen meat traffic between Peru and Europe might readily be inaugurated. Merino mutton is notoriously good but lean; several of the suggested crosses should give an ideal carcase sheep.

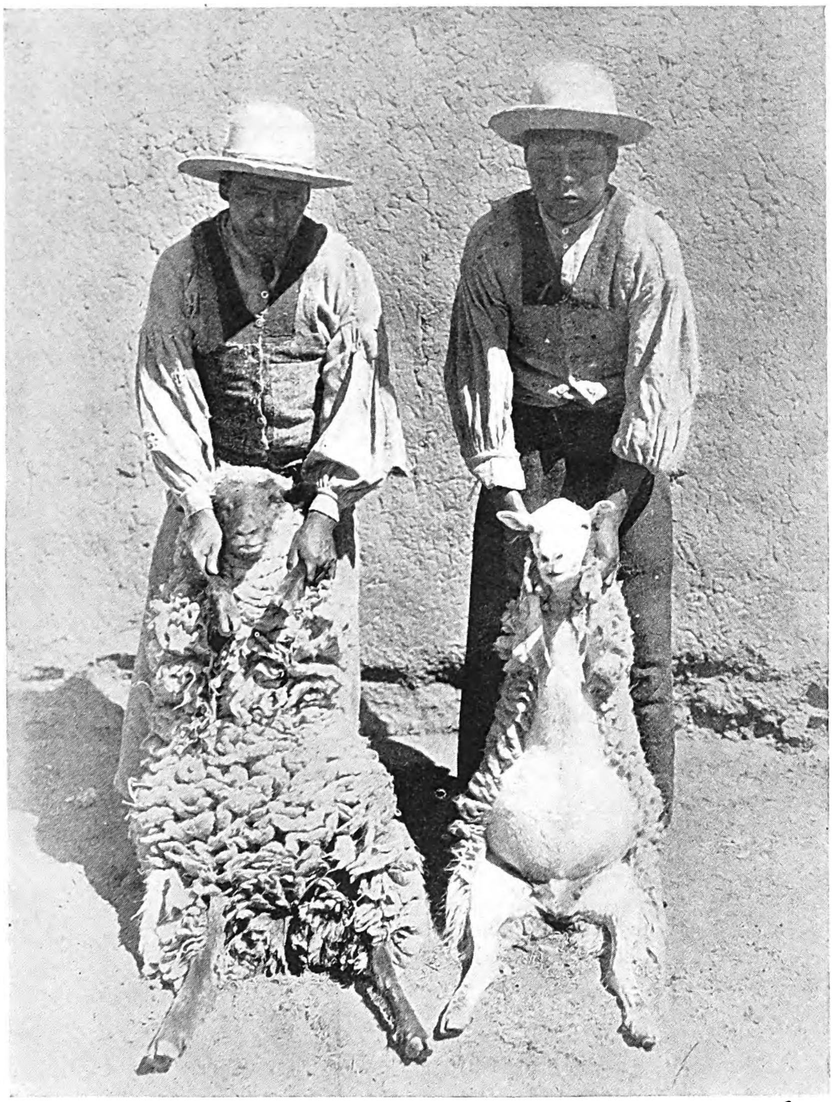


Fig. 4.
NATIVE SHEEP COMPARED WITH IMPROVED SHEEP.
The larger skin area of the half-bred sheep and the better distribution of the wool on the body, accounts for the remarkable increase in the weight of fleece as compared with the native.

It is obvious that a careful survey of all possible breeding types and conditions is at this juncture most desirable, for if the right type of "cross" is adopted and developed upon the right lines, and if a sufficiently large quantity of the Improved Peruvian wool be placed upon the market, so far as can be humanly foreseen success, and probably very marked success, must inevitably follow.

Professor Barker concludes by stating the two objects which were held in view in writing his report: the first, to give that encouragement to Peru in sheep-breeding and wool-growing which is already so well merited; the second, to present the bewildering array of facts recorded, and to be daringly speculative with the object of revealing the extraordinary scope for research with reference to genetics and heredity which the fields covered present.

To illustrate the possibilities resulting from the collaboration of the industrialist, the technologist, and the scientist, reference is made to a case in which the President of the British Wool Federation (Mr. W. Hunter) started the research by stating that Native Peruvian wools were specially useful owing to their milling qualities. As a technologist it was natural that Professor Barker should decide to follow this up by actual experiments with Native and Improved wools, with the result that data on relative felting properties were obtained; and knowing that the rates of milling might be important, he asked Mr. J. B. Speakman, lecturer in physical chemistry in his department, to work out these further particulars. In doing this it occurred to Mr. Speakman that the curves obtained could be analysed into their component factors, and in attempting this he has made discoveries of dominating importance with reference to the milling of wools. These discoveries form a notable addition to the science of the textile industries.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

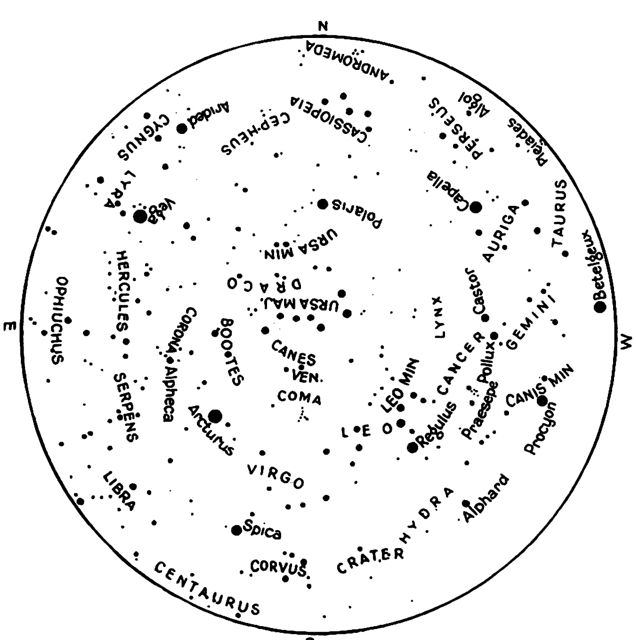
THE FACE OF THE SKY FOR APRIL.

THE southern constellations of the Zodiac, Libra and Scorpio are now coming into view. It should be noted that the times given for the star-map are not in summer-time, but in the old reckoning. This is more convenient than summer-time for all astronomical purposes. Jupiter and Uranus pass conjunction with the sun, and are invisible; but Saturn is approaching opposition, and may be seen after midnight. A small portion of Centaurus is visible on the southern horizon; this constellation contains our nearest stellar neighbour, but this is too far south for us to see.

Two occultations of fairly bright stars may be observed; on the 24th epsilon Geminorum disappears at 10.3 p.m. and reappears at 10.35; on the 25th kappa Geminorum disappears at 9.34 p.m. and reappears at 10.18. These are very pretty phenomena, and observers may do useful work by timing the events to the nearest second, finding the error of their watches by wireless signals.

A New Comet.

A new comet, of the twelfth magnitude, was found by Herr Reinmuth, at Konigstuhl, Heidelberg, on 22nd February; I find that it is a member of Jupiter's family, with a period of about seven years. It was nearest the sun on 1st February, being then some eighty million miles outside the earth's orbit; I was led to expect an elliptical orbit by its small inclination; very few comets moving in parabolas have small inclinations. The great comet that was seen in December has been visible again in February at the Cape and Johannesburg; these observations will permit the orbit to be accurately determined. Encke's comet was also visible in February as a fairly bright object in the evening sky; it was nearest the sun February



THE FACE OF THE SKY AS SEEN FROM LONDON at 12 h. sidereal on 6th April at 11 p.m., on 21st April at 10 p.m.

19.8288, which is three hours later than L. Matkiewicz's prediction. This is the thirty-seventh observed apparition of the comet.

A very ancient solar eclipse, observed at Ur on 23rd February, 2283 B.C., has been identified by Herr C. Schoch. Dr. Fotheringham notes that it agrees with his values of the acceleration of the sun and moon. It is about a thousand years earlier than any previously identified eclipse.

The Drayson Paradox.

There are few astronomical paradoxes that show such tenacity of life as the Drayson paradox. It had its basis in a slightly inaccurate statement in Sir John Herschel's famous work "The Outlines of Astronomy." Herschel says that the pole of the equinoctial (by which word he means the equator) describes a circle in the heavens around the pole of the ecliptic as a centre, keeping constantly at the same distance of 23° 28′ from it. It is clear that he is thinking only of the processional action of the sun and moon on the earth's equatorial protuberance, which would bring about such a circular movement. He, of course, knew of the independent movement of the ecliptic or plane of the earth's orbit, which alters both the centre and radius of this circular movement; but evidently he desired to simplify the description, though the result shows that he was unwise. The cause of the diminution of obliquity is not a mystery, but is perfectly understood by astronomers. The planets, revolving round the sun in planes slightly inclined to the ecliptic, exert a rocking action upon the ecliptic. The planes of all the planets are undergoing continual changes of this character, and so far from the change in the plane of the earth's orbit presenting any difficulty, surprise would arise if it did not take place. And yet, in the face of this exact agreement between theory and observation, Drayson propounded a view that the motion of the earth's pole was taking place not about the pole of the ecliptic, but about a point six degrees away from it. With this first error he mixed up others; he denied that the plane of the earth's orbit was changing, and he denied the reality of the proper motions of the stars, asserting that these were all due to changes in the earth's axial pose. This showed a great ignorance of the nature of the observed proper motions, for no change in the earth could cause the stars to move *inter se*; all the stars in one region of the sky would appear to move together. It is at once obvious, on examining observed proper motions, that they are not of this character, but that each star has its own motion. For example, Capella was one of the stars chosen by Drayson to illustrate his argument; but Capella is palpably moving among the more distant stars that surround it; in fact, Furuhjelm was able to pick out a distant companion of Capella by its sharing the same fairly rapid motion among the slower stars in the background. The surprising thing is that this erroneous teaching continues to attract a certain amount of support; only a few weeks ago Mr. A. H. Barley has brought out a pamphlet, which is calculated to mislead; so it is well to point out some of its errors. He makes the curiously false statement on page 6 that "no shifting of the plane of the ecliptic would alter the measure of the arc between the two poles." This shows a strange ignorance of spherical geometry; every change in the tilt of a plane involves a corres-

ponding change in its pole. He says on page 9 that the obliquity of the ecliptic will reach a minimum about A.D. 2295, or less than four centuries hence; if this were so, it is clear that the rate of diminution of obliquity would be falling off rather rapidly; actually it remains steady at about 47″ per century, as a study of the measured obliquity in different years in the Greenwich Observatory will show.

Mr. Barley falls once more into the same mistake that Mr. E. J. Stone made in 1883; the latter noticed that the errors of Hansen's tables of the moon were increasing more rapidly than astronomers had expected, and asserted that the cause was a change in the ratio of the solar to the sidereal day, brought about by the introduction of new solar tables into the Nautical Almanac. He was correct in asserting that such a change did occur, but very much in error in assigning its amount, which was only about 1/365 of the amount he gave, so that the change that he asserted to take place in a day actually took place in a year. Sir G. Airy, in a letter to the *Observatory* in May, 1883, showed the impossibility of there being such a large error in the solar day as Stone asserted.

The Recent Eclipse.

Mr. Barley also tries to make capital out of the *very small* discordances between prediction and observation in the eclipse of last June. In reality Dr. Ernest Brown is to be warmly congratulated on his success in solving the marvellously intricate problem of the moon's motion. Mr. Barley is hard put to it in trying to get evidence for the Draysonian motion of the pole from these small discordances. It is now looked upon as very highly probable that the small unexplained oscillations of the moon are due to slight variations in the rate of the earth's rotation (not affecting the direction of its axis); these might arise from some rearrangement of matter either on the earth's surface or in its interior.

In conclusion, neither Drayson nor his followers have ever attempted to give any dynamical explanation of their supposed motion of the pole. The received system is in perfect accord both with observation and dynamical theory. The ecliptic is the circle traced by the sun in its apparent annual journey, and it is also the mean position of the (slightly varying) traces of the moon; hence its pole is the natural centre for the polar motion. But what conceivable action could cause the pole to move around a point some six degrees away from this? My excuse for dealing with this paradox at such length is the persistence with which it is brought before the public, and the considerable number of people who have given in their names as its adherents. I imagine that several of them have not studied the evidence for themselves; they have been attracted by the fact that Herschel's language was undoubtedly misleading, and that Drayson gave a specious, though erroneous, argument from proper motions, and another from Ice Ages. Astronomers have never claimed to explain the Ice Ages astronomically. Any claims put forward are mere conjectures.

The photographs of Jupiter referred to in this column in February were by a slip ascribed to Professor Douglas, instead of to Dr. W. H. Wright, by whom they were taken.

Dr. John W. Evans' book, "The Determination of Minerals under the Microscope," was published by Messrs. Thomas Murby & Co. on 24th March. There are many who, knowing Dr. Evans' special knowledge of this subject, have been looking forward to the appearance of this volume. The same firm have a more elementary book on the subject on their list—"Minerals and the Microscope," by H. G. Smith—which is now widely known and used by students.

Book Reviews.

Colour-Music: The Art of Light. By A. B. Klein, M.B.E. (Crosby, Lockwood & Son. 36s.).

For the increasing number of students, in this country and in America, of the analogy between colour and music, and of colour harmonies, this is an epoch-making book. It may be divided into three parts—the first of which, though the least scientific, will be found perhaps of the most general interest.

In his introduction Mr. Klein describes the progress of all art from simplicity to complexity, and states that, in painting, an inter-action is beginning between science and art; he believes that the modern movement is preparing for the birth of an art of light; that is, the art of producing "colour-music" or striking harmonies and "melodies" in colour by the projection of light by mechanical means. He goes on to describe the present degradation of art in the hands of Cubists, Expressionists, etc. He thinks that painters are losing their sense of colour, whereas musicians are becoming prepossessed with it. Then comes an interesting chapter on the Psychology of Colour. The results of experiments on many American students show that colours, as regards their psychological effects, may be roughly divided into three groups, each consisting of one of the three "primaries" and the hues that adjoin it in the spectrum. Thus, the red and orange group are exciting and stimulating, the yellows and greens tranquilly cheering, the blues and violets soothing and subduing.

Mr. Klein next describes synthesia or "coloured hearing." Scriabin and Rimsky-Korsakov had mental images of colours while hearing music (the hue changing with the tonality or key—not with the note); and Scriabin devised an instrument that projected coloured lights according to the tonalities of his "Prometheus" Symphony. Mr. Klein is not inclined to see much in—nor to make much practical use of—the analogy (fascinating to minds both logical and aesthetic) between most aspects of colour, and of music. But in the second part of his book he gives a fair-minded historical survey of the analogists, beginning with Aristotle! Newton first compared the spectrum colours, and the notes of the diatonic scale, with regard, in each case, to their vibration-ratios. Chevreul, in his important work on Colour (1839) was perhaps the first to tackle the subject of colour-harmony. He noted the effects of both simultaneous and successive contrast. He also arranged the first of the many colour circles. He divides his harmonies into two species: harmonies of analogy, and of contrast; and states that, in the latter, the complementary arrangement is superior to any other—but he got his complementaries wrong. The reviewer believes that true complementaries form a harsh discord; so does Mr. Jacob, head-master of the New York Technical Art School, author of "The Art of Colour"; also Professor Rood (mentioned later in Mr. Klein's book).

Theodor Seeman, who published "The Laws of Colour-Harmony" (1891), first compared a scale of twelve hues with the twelve semi-tones of the chromatic scale. The next important writer on Colour, Professor Ogden Rood, in his "Modern Chromatics," wrote in an original manner about harmonies. He is against obtaining balance by juxtaposing hues which, if mixed, would produce a neutral grey, *i.e.*, complementaries.

The great Helmholtz, in his "Physiological Optics," mentions the colour and music comparisons. He has no great opinion of them, but recognizes that: "The saturated colours form,

really, a continuous series among themselves, if we replace by purples the void which exists between the spectrum's extremities."

Ruskin has a fine passage on the colour-harmonies found in Nature. And who (the reviewer humbly asks) would admire the rainbow were its hues not "chromatically" arranged, and were complementaries next each other?

Space forbids mention of more of the writers touched upon—except Ostwald, who in his monumental "Colour-harmonies," (1918) postulates: "Only those colours are in harmony which bear simple, definite relationship to one another." He finds, also, that this harmony depends more on their respective saturation and luminosity, than on their hues. A chapter follows giving a full account of the colour—and the colour and music analogy—but Mr. Klein finds the analogy imperfect, chiefly because the complementaries are not of *simple* ratios, as are the concords in music. But, as above stated, complementaries are *not* concords.

The last part of the book is concerned with colour-music as an independent art, and with the various instruments that have, at different times, been invented for projecting coloured light on to screens, etc. Then comes a chapter on Stage Lighting; and next, a detailed description of Professor Rimington's famous colour-organ, and other instruments; and, most ingenious of all, the author's own Colour Projector.

MARY BARNE.

Columbus—Undergraduate. By JOHN A. BENN. (London: Ernest Benn Ltd. 6*s*. Philadelphia: J. B. Lippincott. $2.)

(REVIEWED BY PROFESSOR ROBERT MCELROY.)

This little book is intended neither as a scientific discussion of the ideal university curriculum nor as a mere tale of undergraduate adventure. It is submitted as evidence upon a very important question of international education now in the early stages of experimentation, *viz.*, the value of the system of exchange of university students between nation and nation.

In its present form, that question dates from the will of Cecil Rhodes, but George Washington, when seeking to devise ways and means to break down unreasonable prejudices which so long prevented the effective union of the American States, thus clearly stated it in his last will and testament: "It has been my ardent wish to see a plan devised on a large scale, which would have a tendency to spread systematic ideas through all parts of this rising empire, thereby to do away local attachments and State prejudices, as far as the nature of things would, or indeed ought to admit, from our national councils. Looking anxiously forward to the accomplishment of so desirable an object, . . . my mind has not been able to contemplate any plan more likely to effect the measure, than the establishment of a university . . . to which the youths of fortune and talent from all parts thereof may be sent for the completion of their education."

Washington's problem was that of destroying "local prejudices and habitual jealousies" among certain self-conscious and rather provincially-minded American Commonwealths. Cecil Rhodes envisaged the same problem from the point of view of a British Empire striving after unity. But in recent years many far-sighted men have devoted vast sums of money to the task of applying the same method to a world seeking international unity.

The interest of Mr. Benn's *Columbus—Undergraduate* lies, therefore, not so much in his educational theories, or the facts which he presents. It lies rather in the concrete evidence of what his years in Princeton did toward widening his horizon, removing unsound prejudices and making him a more tolerant and appreciative neighbour to those who dwell in lands other than his own. If his book gives evidence that this has been accomplished, it is one case in favour of the theory upon which so much wealth and intellect are to-day being generously lavished.

The first two sections are designed to show how Mr. Benn happened to make his experiment of taking a year in Princeton, before entering Cambridge. The "evidence" therefore begins with section three, "The Freshman." "Some newcomers," he remarks, "are repelled at once by the American accent, whereas, of course, it is the Englishman who has the accent when he lands in the United States." The remainder of this chapter is but an illustration of the adaptability of youth, and an illustration of the fact that the capacity to see two sides is the key to peace, at least during the trying days of Freshman year.

The engaging frankness with which Columbus confesses, on page 18, that he "secured just 12 per cent in the entrance examination in American history," and then makes three errors of fact on the same page,* does not serve to destroy the value of the chapter as an indication of changing mental outlook. What are facts among friends, and the final sentence on the page gives the evidence of growing consciousness of friendship. "The British tradition flourishes as much in Princeton as in any town in the country."

The next chapter, "Education for Everyone," is a brief, sane comparison of the aims and limitations of the American theory which has called 726,000 into higher education, with the English theory which has called only a small percentage of that number.

In Chapter V, "Earning and Learning," Mr. Benn gives, with perfect frankness, his attitude toward the man who "works his way through college," whether as waiter, laundry man, furnace tender, or shop clerk in vacation. "The whole college," he says, "is the gainer for the earnestness of men who want their education that hard," and he quotes statistics to show that, even in an expensive university like Princeton, they are gratifyingly numerous.

Of the systems of study which he considers distinctly American and distinctly English, he concludes, with perhaps an unfortunate failure to look at the "final cause," that "the former system is an advantage to the greater number, while the latter disregards the majority in favour of the few." It would perhaps be fairer to the English system which concentrates upon the few to consider whether that is necessarily a disadvantage to the many. Not a few American educators are now venturing to raise the question whether the Democracy might not be better served if the universities should eliminate a not inconsiderable percentage of their present numbers, and give the benefits of their rich endowments of equipment and able teachers to those who are best fitted by mind and temperament to profit by them.

The little chapter on "Prohibition" may serve to answer some questions, and perhaps diminish some prejudices regarding the American university and the XVIII Amendment. At any

*The College of New Jersey was not "founded by Royal Charter of George II, granted in 1748." It was founded and chartered in 1746, but a new charter was granted in 1748. "The preliminary drafting of the Declaration of Independence" did not take place in Nassau Hall; and the first President of the College did not sign the Declaration of Independence. Indeed, the first President, Dickinson, had been dead almost thirty years when the Declaration was signed. It was John Witherspoon, the sixth President, who signed the Declaration.

rate, the earnest inquirer after truth in this field can well afford to read what this English undergraduate in an American university saw, and to consider as evidence what he failed to see.

There are other features in *Columbus—Undergraduate* which deserve mention, but in the last chapter he came very near to a specific answer to the test suggested at the beginning of this review: "impressions are now so interwoven that to think separately of America is impossible." If that is the conclusion of the whole matter, it should stand as at least one clear note to encourage the generous philanthropists who are seeking to remove "local prejudices and habitual jealousies" by enabling the students of one nation to study in the universities of other nations.

In Search of our Ancestors. By MARY E. BOYLE. With a preface by the ABBÉ BREUIL. (George Harrap. 10s. 6*d*.).

"Begin at the beginning," said the king, "then go to the end and stop." This is probably the ideal way of presenting a sequence of events, but if every author had kept to this scheme there would have been no Sherlock Holmes, no Gold Bug, nor a host of other stories. The detective approaches his case with a knowledge of the facts as they stand, and it is his business to unravel the general sequence of events which gave rise to his problem. And it is in the position of a detective that Miss Boyle approaches her subject.

To a staunch evolutionist her method seems the wrong way to tell the story of primitive man; in fact, it savours of the well-known scheme of putting the cart before the horse, and yet it has its virtues. Lyell used it with great success, and he steadfastly maintained that the only way to treat geology, or, for that matter, prehistoric archaeology, was to travel from the known to the unknown, and from the familiar to the less familiar. This book is definitely intended to take the reader back through time to the very beginnings of the human race, and we travel from the Iron Age through the intervening cultures until we reach those pre-Palaeolithic mysteries, so fascinating and yet so problematical.

It is apparently not realized to any great degree how extensive the Celtic civilization really was, and how far it was influenced by those of Greece and Rome, but a fascinating picture is drawn of the northern warriors leaving their wooded homes to exchange their iron weapons for the vases and pottery of the Greeks which they prized so highly. The Bronze, Copper, and Neolithic Ages are traversed, until we reach the Palaeolithic Age, the account of which takes up half the book. The matter throughout is excellent and extremely well presented, and the large number of plates add greatly to the general interest. One could wish for more pictures of the weapons used by these long-vanished peoples, for they are all-important in chronology, but the reproductions in colour of the cave-paintings leave nothing to be desired. There are also many plates of skeletons, and of burials, together with numerous examples of sculpture. Miss Boyle says that the Magdalenians were probably unacquainted with the bow, and yet talks glibly of the paintings of arrow-heads and of carved arrow-straighteners. Again, she certainly gives the impression that in Mousterian times it was customary to knock a flake from a nodule, and subsequently to trim it on one side only, instead of chipping the block first, and detaching the worked portion by a single blow, as outlined in Professor Sollas' book "Ancient Hunters." It seems unfortunate, too, that the author has chosen that particular reproduction of Crô-Magnon man which has become known as the "professor of philosophy," and the book would have been much better had it included restorations of Mousterian man and of the earlier hominids.

The relationships of man and the Ice Age are discussed very ably, but it is doubtful if the Alpine chronology of four glaciations can be applied with any certainty to those areas directly under the influence of the Scandinavian ice sheet. Nevertheless, the suggestions that the cold Weybourn Crag may be connected with the Günz glaciation, and the Arctic plant bed with the Mindel, are both interesting, and bear some probability.

Good as Miss Boyle is as a prehistorian, her geology is not so strong, for in her concluding chapters on the earlier history of the earth there are several minor inaccuracies. It is not usual to say that the Triassic system is so-called because in Germany it is composed of an upper marl of Cretaceous age, a middle "chalk" of Jurassic age, and a lower sandstone of Triassic age. Diplodocus, we are told, used its tail and long neck to force its way through thick brushwood, and it seems as if there was a "grass-eating Dinosaur" and also a "flesh-eating species." But it is not as a geology book that we should regard this volume. It is a brave attempt to trace our ancestry back into the unknown, and it certainly gives a general view of prehistory unusually connected and complete. A preface by the Abbé Breuil insists that evolution is only a process, and although by it we are better able to appreciate the general flow of life, it affords no information on the mechanism of its working. The book possesses a time-scale which is particularly interesting in that it connects the pre-historic with the historic; a copious list of references; and a comprehensive index.

J. E. HALLIDAY

Creative Education in School, College, University, and Museum By HENRY FAIRFIELD OSBORN. (Charles Scribner's Sons.

In this work a highly-distinguished man of science, eminent as a discoverer and as one who has concerned himself greatly with the wider issues of science, summarizes "personal observation and experience of the half-century 1877-1927." Animated by a desire to tell the world the chief lessons he has learned, Professor Osborn sets out with great earnestness to propound a doctrine to which he gives the name "creative education." The reader will be eager to discover as soon as possible what meaning is to be attached to this term, what lies in it to bring new light or give him fresh guidance as student, investigator, or teacher. The reader, we are afraid, is doomed to disappointment, for creative education is, it appears, nothing but education which will be so conceived and conducted as to preserve, stimulate, and allow scope for development of the creative power and potentiality with which every human being is to some degree endowed. Creative education is, in fact, simply education of the kind which has been commended by educational prophets throughout the ages and has been practised within the limits of their ability and opportunity by every really liberal-minded teacher. It is untrammelled education. Such education surely need not or should not be called creative because it aims at making the subject creative—any more than education which helps a good inventor might be called inventive education. There seems to be a confusion of terminology. But we soon learn what is the real faith that lies behind it, and discover what it exactly is that Professor Osborn so earnestly seeks to impress upon us. What he, in fact, does in the book is to give us something like a record of his own educational beliefs and proclamations, together with an account of the

way in which he brought into existence the remarkable body of pupils who have followed his ways and risen to high distinction in the world of science. To these men the book is dedicated, and portraits of fourteen of them are interspersed in the text. We can easily understand the pride with which Professor Osborn looks upon his disciples, and the vindication they afford of the educational methods that he has propounded and followed throughout his strenuous life.

As we have already said, there is nothing in the broad educational principles advocated in this book that is likely to be challenged. As the outspoken opinions of one of the most distinguished men of science in America it has much of interest for the English reader. We have a criticism of American educational ways in schools and colleges old and new, an account of the proposed Washington-La Fayette school for boys in France, a discussion of science teaching of museums as a new force in education, excursions into philosophy, and much that is of lively interest in the occasional addresses of which the book is so largely compounded. This kind of compilation involves a good deal of re-iteration and makes somewhat restless reading, but the book has the merit of reflecting vividly the personality and ways of a man who has done great things.

A. SMITHELLS.

The Human Body. By TREVOR HEATON, M.D. (Chatto & Windus. 7*s*. 6*d*.).

Dr. Heaton writes of the human body as a living, purposive thing, taking us from organ to organ and describing the minute complexity of their structure in terms of function and of their manifold relations with one another. He links up the slightly esoteric lore of the physiological laboratory with the common experiences of everyday life, telling us why our blood and tears are salt and why, when we warm our hands, we hold them palm-foremost to the fire, and explains many normal processes by their relation to those physiological phenomena which force themselves upon our attention when the machinery gets out of order.

Vitamins and ductless glands, which have won for themselves a certain amount of popular interest and suffered a good deal from popular misrepresentation, are plainly set forth in their true perspective, and all readers will be grateful to Dr. Heaton for his introduction to the physiological poet who has so admirably summarized the present position of endocrinology in the couplet :—

" Big glands have lesser glands to govern and unite 'em :
The scheme of their relationship extends *ad infinitum*."

The book makes no vociferous claim upon our wonder or astonishment, for Dr. Heaton writes clearly, simply, and persuasively in the best tradition of scientific literature ; but only a very dull or unimaginative reader will fail to receive an impression of rare beauty from the picture which the book slowly and patiently presents to him. The beauty is more subtle than that which strikes us from the naked and polished efficiency of the best machines, for behind those delicate and ingenious processes in the living organism that we know and understand, stretch vista after vista of other processes which are wholly or partly inexplorable and offer a continual challenge to the imagination.

The last chapter shows us disease and death from the philosophic standpoint of physiology, lifting them out of the depressing and sometimes discouraging aspect which they naturally present to the merely personal and anthropocentric point of view ; and this chapter, with the one upon the physiology of reproduction, will be a most valuable introduction to these large problems for those who are growing up and meeting them for the first time.

Dr. Heaton is to be congratulated upon the success and distinction with which he has treated probably the most difficult of all the subjects in the publisher's " Simple Guide Series."

F. A. HAMPTON.

Practical Television. By E. T. LARNER. With a Foreword by JOHN L. BAIRD. (Ernest Benn Ltd. 10*s*. 6*d*.).

This book affords a comprehensive survey of the whole field of television. The history and development of the attempts to transmit visual objects by radio are collected and discussed with descriptions of all the principle apparatus, including, by special arrangement with the inventor, the most recent researches. There are a number of illustrations with diagrams of apparatus, and also actual photographs of transmitted pictures. The average person may, from this book, learn how to connect his existing radio set to televising apparatus, although this latter is still at a very elementary stage. With the help of Mr. Baird the whole subject is here transferred from the realm of theory into the realm of practice.

Photographic Exposure.

THERE are so few people nowadays who do not possess a camera of some sort that it is surprising that the average quality of snapshots does not reach a higher level. It might be interesting, if the task were not so stupendous, to analyse the various defects which amateur photography shows. We have no accurate data to go upon, but we suspect, from our own observations, that such analysis would reveal that a comparatively small number of failures are due to faulty selection or posing of the subject, and that an overwhelmingly large number are due to an inability to use the correct stop and to give the correct exposure. This result is surely rather remarkable, for selection of the subject is really an aesthetic matter which can hardly be governed by rules, and exposure is a question of scientific facts. There are many contrivances to enable the photographer to make the necessary calculations—contrivances which, indeed, actually provide the calculations ready made, but curiously few of them are used in proportion to the huge number of cameras in active existence. The latest piece of ingenuity in this direction which has come to our notice is the Justophot, patented by Dr. Emil Mayer, and sold by Sands, Hunter & Co., 37 Bedford Street, London, price one guinea. This little machine gives its information through actual focussing with the eye, but the focussing, it should be noted, is not of the subject itself, which is frequently a difficult thing to get into sharp outline, but of a small white numeral that appears in a dark field of vision. The instrument is so simple in its working that it can be used by the amateur who does not concern himself with anything but the extra rapid plates or films of the ordinary hand camera. It is also so complete that the skilled photographer can make adjustments to suit the requirements of any sort of special plate that he may wish to employ, and the demands of such differing subjects as interiors and snow scenes, still life and seascapes are all taken into account.

C. H.

DISCOVERY

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Editorial Notes.

IN Palestine the archaeologist is peculiarly favoured by the contemporary accounts which are usually to be found in the Old Testament, and the site of Beisan is no exception. For centuries this ancient city was a key to the great highway from the Mediterranean to Transjordania, and remains of nine city-levels dating down to Arabic times have been found there by the American expedition. A special report is contributed this month by Mr. Alan Rowe, who has been Field Director since 1925, and was previously with the same expedition—as assistant—in 1922 and 1923. During the two years intervening he excavated in Egypt at Thebes, Girgeh, and the Gizeh Pyramids, also at Semneh in the Sudan. The latest layer unearthed at Beisan contains two Canaanite temples of 1500 B.C.; one of these was made for the god Mekal, whose name is here met with for the first time in archaeology. It seems quite certain that Mekal is a form of the god Resheph, the name undoubtedly referring to the great heat and general unhealthiness of Beisan in the summer time. Among the incidental finds are a number of clay objects, representing rolls of bread or cakes; these may throw light on the altar bread ceremonies recorded in the *Book of Samuel,* where the frequency of renewal is unspecified.

* * * * *

The advent of ethyl petrol in England has at once been greeted with storm of "warning" by various well-known chemists as well as by politicians, with the result that its use has been referred to a Government Committee for expert opinion. In view of the mass of evidence already collected in America, this step is difficult to justify, but at present we seem to be passing through a phase in which a committee is regarded as an almost divine dispensation for any problem or trouble. The critics of ethyl petrol appear to have confused the manufacture of tetraethyl lead with commercial ethyl spirit, which contains only one part in 1,300 of the former dangerous substance—a proportion proved not to cause the slightest danger when used as motor fuel. Last year over 500,000,000 gallons of ethyl petrol were sold in America. Official investigations there have not so far found a single case of ill-effects from its use, though certain precautions in handling are advised. The new spirit is claimed as a wonderful discovery, adding remarkable properties to ordinary petrol, and prejudice against it is unjustified on present evidence.

* * * * *

After many disastrous attempts to fly the Atlantic from east to west, success was achieved on 13th April. The German aviators, Herr Köhl and Baron von Hünefeld, were accompanied by Commander Fitzmaurice, of the Irish Air Force. Of all the attempts so far made, this was probably most deserving of success: we do not detract from the courage of previous flights in regarding them mainly as adventurous exploits. The victors, however, had approached the task in a scientific spirit from the moment when they turned back last year on their first attempt, the weather proving unfavourable. The machine was a Junkers monoplane. By a happy coincidence the French flight round the world ended on the following day, 14th April. Captain Costes and M. Le Brix left Paris for Buenos Aires last October, and had made the southern Atlantic crossing in stages.

* * * * *

At the time of writing, troubles are impending again in China, but it is always difficult to obtain from the press an adequate idea of their significance. An illuminating detail has just reached us from an American correspondent, in an appeal for funds for the Princeton University Mission in Peking. Of late this work has been concentrated in the teaching of

sociology at Peking University, where the best of Western culture is given to a select group of Chinese students; the main purpose of the mission being "to train young men and women of China for the modernization of their country." The reader begins to picture the oriental eyes already opening wider behind horn-rimmed spectacles, rapidly becoming imbued with efficiency, when he reads on as follows, in connexion with recent expenditure: "To prevent any disturbance by marauding war lords, a great wall has been built round the grounds of the university by its many devoted supporters. As a result the university has not been closed a single day during the recent civil strife." We looked at the letter again, but it was not written in the Middle Ages—the postmark was Chicago, March, 1928.

* * * * *

On another page this month, dealing with the new star in Pictor which has just caused a sensation by becoming double, Dr. Crommelin remarks on the spasmodic character of popular interest in astronomy. While astronomers are pleased at seeing such a large amount of attraction in this occurrence, they would be still more glad if the interest were a permanent one. There are countless marvels continually present in the heavens, but these attract little public interest; whereas anything of a bizarre nature, such as the Pictor occurrence, relating to a pair of faint telescopic orbs far out of reach of European observers, produces flaring headlines in newspaper placards, and occupies many columns of text. We may, at least, assure Dr. Crommelin that his own efforts are not wasted on the many who enjoy his notes every month in *Discovery*.

* * * * *

Conditions in Europe have been changing so rapidly since the war that to follow them intelligently has for most people been frankly impossible. The greatest interest therefore attaches to a series of lectures recently delivered at the City of Birmingham Commercial College, and now collected in a volume* edited by the principal, Mr. Henderson Pringle. As no limitations were imposed, the lecturers naturally approach their subjects from differing angles; the Hon. George Peel, for example, discusses France on the general basis of statistics, in particular regarding the monetary crises through which she has passed since the war. The choice of the writer on Italy was, however, an unfortunate one for a series of impassionate studies: Professor Salvemini could hardly be expected to take any but a partisan view of the Fascist regime from which he is in exile. Of quite other character is Mr. Michael Farbman's essay on Russia, to which one naturally turns with great curiosity. While frankly criticizing the new conditions where criticism is called for, he approaches the subject with sympathy and an obvious insight into the psychology of the Russian people. The knowledge of the Revolution that has accumulated during the last ten years enables us quite safely to declare that not only the upheaval of February, 1917, which overthrew the Monarchy, but all the subsequent stages were clearly connected with the Agrarian Revolution of 1905, and, in fact, derived their driving force from it. For the future, as between socialism and capitalism, Mr. Farbman states that "it cannot be doubted for a moment" that the tendency of Russia is towards capitalism. The peasant has at last become a conscious factor in Russian history and has now, as it were, turned his face to Europe. "The future of Europe," we are told, "may depend on whether this present occidental tendency meets with welcome or repulse."

*"Economic Problems in Europe To-day" (Black, 5/-).

* * * * *

A curious problem about a bird which flew through a plate-glass window without damaging itself is advanced by Sir Herbert Maxwell in a letter to *The Times*. On entering the room his first thought was that a football had been kicked through the pane, so round was the hole; but soon a hen-pheasant was discovered crouching by the fireplace. "We are told," says Sir Herbert, "to regard force as no more than the rate per unit of length at which energy is transferred or transformed; but this does not carry the ordinary citizen far towards understanding how a hen pheasant's beak can be driven uninjured through plate-glass, or how the slender cannon-bone of a horse may suffer no abrasion in smashing an oaken rail; whereas if the same oaken rail were driven against the leg of a stationary horse there can be no doubt which would be shattered. It is said that a man may drive his fist through the panel of a door if he aims resolutely at a point a foot behind the panel—the experiment is not likely to become popular; but the horse, in striking and breaking the rail, is aiming at landing in the field beyond. So the hen pheasant, deceived by the reflection of a woodland glade in my library window, was unconsciously directing her flight at something on the far side of the glass." Everyone who lives in the country has seen a small bird fly against a window, often repeatedly as if it failed to see the glass. The beak might readily pierce the glass undamaged, but how a hole occurred of sufficient size to admit the body remains a mystery.

The New Discoveries at Beisan.

By Alan Rowe.

Field Director, Palestine Expedition, University of Pennsylvania Museum.

In a specially-contributed article, Mr. Rowe deals with the American excavations at Beisan. Two Canaanite Temples of Thothmes III, dating back to **1500 B.C., *are new discoveries on this remarkable site.***

EVER since 1921 the Palestine expedition of the Museum of the University of Pennsylvania has been engaged in excavating the site of the ancient city of Beth-Shan, at present called Beisan, which lies in north Palestine at the eastern end of the valley of Jezreel. This city, which since time immemorial had been the key to the Jordan end of the great highway extending along the valleys of Esdraelon and Jezreel, from the Mediterranean Sea to the country now known as Transjordania, is to-day represented by a small town resting on the southern side of the River Jalud, a swiftly flowing stream which runs eastward into the River Jordan. Between the town and the River Jalud is Tell el-Hosn, or " Mound of the Fortress," which chiefly consists of the remains of super-imposed citadels ranging in date from the earliest age to Arabic times. On the north side of the mound, and on the other side of the river from the tell, is an extensive cemetery—one of the largest in Palestine—which has been proved to contain burials of all periods, from the Early Bronze Age to the Byzantine Era.

Up to the present nine super-imposed citadels, or city-levels, have been found on the tell, particulars of which are given in the list below.* (It should be noted that during the time from 1374 B.C. to 1314 B.C., the temple of Amenophis III was still in existence, so that No. VII level may really be said to have come to an end at the latter date.)

In this article we are only concerned with the two temples belonging to the time of Thothmes III, which were found during the 1927 autumn season; these temples are essentially Canaanite in origin, and had no connexion whatever with Egyptian archetypes. They were all made of brick, and had their walls covered with plaster.

Southern Temple of Thothmes III.

The great southern temple of Thothmes III is about 138 feet in length from south to north, and its excavated width is more than eighty feet. The axis of the temple lies from south to north. The temple consists of:—

(1) *An Inner Sanctuary.* This has a central brick altar, twenty-two inches in height, with a flight of three steps leading up to it. On a small wall to the right of the steps is a shallow stone basin which held the blood offerings for the deity. This altar was chiefly used as a table for the various sacred objects, jewellery, beads, etc., which were found lying on the ground around it. The sacred objects consist of a beautifully decorated chalice of pottery; a two-handled cylindrical cult object for holding the flowers, fruit, etc., which were placed in it during the festivals connected with the renewal of vegetation; a well-made pottery figurine of the goddess Ashtoreth; an ivory cosmetic pot on a stand; two gold pins of Cypriote type; a panelled Cretan altar with a cross in high relief on its top (the cross was a general indication of " divinity "); a gold-covered figurine of a god; a magnificent amethyst scarab of Sesostris I, a king of the XIIth Dynasty, 1970-1935 B.C.; a steatite mould for articles of jewellery; many scarabs and scaraboids; and a Hittite dagger with a curved end. This dagger is very much like a dagger worn by a king represented on a gateway in the Hittite capital of Boghaz-keui in

*City-Level	Historical Periods represented by each Level.	Dates.
IX.	Thothmes III. (*Two Canaanite Temples*—southern one made for " Mekal, the god of Beth-Shan ")	1501 B.C.—1447 B.C.
VIII.	Pre-Amenophis III	1446 B.C.—1412 B.C.
VII.	Amenophis III. (*Canaanite Temple.*) Length of reign	1411 B.C.—1375 B.C.
VI.	Seti I. Two levels—Late Seti; Early Seti. (*Canaanite Temple*)	1313 B.C.—1292 B.C.
V.	Rameses II. (*Two Canaanite Temples*—northern one, " House of Ashtaroth " of 1 *Sam.* xxxi, 10, and southern one, " Temple of Dagon " of 1 *Chron.* x, 10. Both were in use until at least Israelitish times, *i.e.*, c. 1000 B.C.)	1292 B.C.—1225 B.C.
IV.	Late Ramesside, Philistine, Israelite, Assyrian, Scythian, New Babylonian, Old Persian, etc.	1224 B.C.— 302 B.C.
III.	Hellenistic. (*Temple.*) Jewish and Roman	301 B.C.— A.D. 329
II.	Byzantine, or Eastern Roman Christian. (*Circular Church*)	A.D. 330— A.D. 636
I.	Arabic. (*Mosque*). Crusader, etc....	A.D. 636—19th century (approx.).

Anatolia; and in this connexion it is interesting to mention the fact that the axe which the king holds is very similar in type to an axe found in the Canaanite temple of Amenophis III at Beisan during 1926.

In front and just to the south of the brick altar is another altar, some twelve inches in height, which is made out of two pieces of stone, one circular in shape and one rectangular. The former stone is placed against the eastern end of the latter. Upon this stone altar were probably laid the cooked meat sacrifices which were offered up to the deity. As a matter of fact, we actually found the shoulder-blade of a young bull near the altar. This shoulder-blade is most important, as it forms part of an animal-sacrifice made in the temple, to which we shall refer later on. The sanctuary of the southern temple of Thothmes III is but an earlier type of the sanctuaries of Amenophis III and Seti I in the upper levels. The later sanctuaries, however, had the northern altar erected in a room raised above the level of the room in which the southern altar was placed. The two temples of the time of Rameses II at Beisan were evolved from a different type of building altogether.

(2) *Room with Altar of Sacrifice.* Immediately to the south of the inner sanctuary, from which it is divided by a thick wall, is a room containing a great altar of sacrifice. This altar is built up against the west end of the above-mentioned wall, and has two steps leading up to it from the entrance passage of the sanctuary. On top of the lower step is a rectangular slab of basalt, which perhaps was originally part of the altar itself. The altar is of brick, and is about twelve inches in height. In the top of it is an L-shaped channel, eight inches in width, and eight inches in depth, in which the blood from the sacrificed animal was carried away to an outlet at the east of the altar. In the southern side of the longer part of the channel is a hole for a wooden peg for tethering the animal to be sacrificed. Just against the south side of the altar were lying the two horns of a bull that

THE NEWLY-DISCOVERED TEMPLES OF THOTHMES III AT BEISAN.

On the back wall of the large cutting made in the mound various city-levels are indicated. This view is taken looking north-east, and shows a section of the southern temple, together with the partially excavated northern temple. Notice also the inner sanctuary.

material. Just to the south of the column is a basalt libation cup sunk in the floor; this was for the purpose of catching the blood offerings that drained off the column. The floor around the column and the cup is made of bricks. The southern corridor and the *mazzebah*-room were doubtless the only parts of the temple in which the laity were allowed; the inner sanctuary was, of course, strictly reserved for the priests. There are four small stone bases near the *mazzebah*, three of which doubtless held sacred objects.

The God Mekal.

The other stone seems to have been a base for an Egyptian stele which we found in the debris a little to the west of the room. This stele is of great importance, as it gives us the actual name and epithet of the local god who was worshipped in the temple itself, that is to say, "Mekal (or Mekar), the god of Beth-Shan." From the inscriptions we learn that the monument was made for a builder named Amen-em-Apt by his son Pa-Ra-em-Heb. Mekal is represented as seated on a throne holding the *was*-sceptre of "happiness" in his left hand, and the *ankh*-symbol of "life" in his right hand. He wears a conical helmet with two horns fixed to the front of it. Attached to the back of the helmet are two streamers, one at its top, and one at its base. The god is bearded and wears an ornamented collar. It seems quite certain that Mekal (whose name is here met with for the first time in the history of archaeology) is a form of the god Resheph, who is sometimes represented like Mekal. "Resheph" means "fiery shafts," "burning heat," "pestilence," etc. "Mekal" is probably connected with the verb *akal* (*aleph-k-l*)—see, for instance, II *Kings*, i, 14—meaning "to devour." If this is so, the attributes of Resheph the god of heat and pestilence are practically the same as those of Mekal, "The Fierce Devourer," whose name undoubtedly refers to the great heat and general unhealthiness of Beisan in the summer time. On the other hand, it might be that the word *Mekal* is an intentional transposition of the word *Melak* or *Malek* (=Molech—see *Jeremiah*, xxxii, 35), "king," the god of devouring fire and pestilence. A figure of a god dressed like Resheph was found in the southern temple of Rameses II at Beisan. In Phoenician inscriptions of the fourth century B.C. found in Cyprus, are references to a god called Mekel or Reshep-Mekel, the latter being translated into Greek as "Apollo Amyclaeus." It may well be Mekel is a later form of the older deity Mekal worshipped at Beisan. The association of the former god with Reshep (Resheph) is interesting.

Over a hundred cigar-shaped objects of mud, each three and a half inches in length, were unearthed in the southern corridor of the temple. These are evidently votive offerings, and doubtless represent small rolls of bread or cakes. Compare *Jeremiah*, vii, 17, 18: "Seest thou not what they do in the cities of Judah and in the streets of Jerusalem? The children gather wood, and the fathers kindle the fire, and the women knead their dough, to make cakes to the queen of heaven (*i.e.*, Ashtoreth), and to pour out drink offerings unto other gods."*

(4) *Courtyard West of Inner Sanctuary.* This courtyard contains two rectangular table-like structures of brick, with a small square pedestal of brick between them. Upon these tables were doubtless placed those portions of the sacrificed bull which were not offered up to the deity in the inner sanctuary. Probably these portions were eaten outside the temple, or in its southern corridor, by the laity, and the portions for the deity were eaten in the sanctuary by the priests (cf. I *Samuel*, ii, 14, 15, and I *Samuel*, i, 18, in the LXX, also Driver, *Books of Samuel*, p. 15). The small pedestal between the tables may have held the implements with which the flesh was divided, cf. *Ezekiel*, xl, 42.

(5) *Room North of Sanctuary.* There is a large room to the north of the sanctuary. Upon its walls and also on those of other rooms are pedestals of brick, which were probably used for the purpose of supporting the posts holding the boards with which the temple seems to have been screened.

As will have been seen from the above description, the great southern temple of Thothmes III at Beisan is one of the most remarkable sacred buildings of its kind ever found in Palestine.

Northern Temple of Thothmes III.

The building, which we have provisionally called the northern temple of Thothmes III, is about eighteen feet to the north of the great temple of the god Mekal, and is not yet entirely cleared. From what can be seen the temple is rectangular in shape, with a dividing wall running across it from south to north. On its eastern wall are four brick pedestals. On the north side of the temple is a flight of five steps leading to a lower level. The temple

* A votive cake of clay found in the Seti I level at Beisan had a seal bearing the Egyptian words "daily offering" impressed upon it fourteen times, which indicates that the cake was an offering for providing a daily supply of bread for the deity. The daily preparation of the bread in the Seti I instance may well throw considerable light on the periodicity of renewing the bread as recorded in I *Samuel*, xxi, 6, where the frequency of renewal is left entirely undetermined. Compare the *later* seventh-day renewal in *Leviticus*, xxiv, 7, 8.

STELE OF THE GOD MEKAL.
This inscribed column shows the Egyptian representation of the local Baal, and is of great importance as giving the actual name of the god. The Canaanite representation consisted of the *Mazzebah*.

was apparently dedicated to the female counterpart of Mekal. The two temples in this level form an analogy to the two temples in the Rameses II level, one of which was dedicated to a god (Resheph) and the other, the smaller of the two, to a goddess (Antit).

Just outside the northern temple we found a bowl with an undulating serpent represented on its side. This object is of great importance, as it indicates that ophiolatry, so prevalent in the town during the reigns of Amenophis III, Seti I and Rameses II, was already practised there in the time of Thothmes III. In view of the fact that the excavations have shown that Beisan was the centre of a great serpent-cult in Palestine, one wonders whether its ancient name, "Beth-Shan," or "House of Shan," reflects a far distant connexion with the old Sumerian serpent-deity whose Semitic name was "Shahan" or "Sakhan." The Museum of the University of Pennsylvania actually possesses a cylinder seal showing the figure of Shakhan.

We shall, of course, never know the exact details of the worship carried out in the Canaanite temples at Beisan, but we can form some idea of its nature by an examination of the various cult objects, altars, and other remains found in the sacred buildings. If an ancient Hebrew could have visited the temples he would doubtless have observed, like the author of *The Epistle of Jeremy* (beginning of IVth century B.C).—who has left us the following account* of what he apparently saw in the temples of Babylon—the

"Gods of silver, and of gold, and of wood, . . . which cause the nations to fear. . . . Their tongue is polished by the workman, and they themselves are overlaid with gold and silver; yet they are but false, and cannot speak. . . . Having no feet, they are borne upon shoulders, whereby they declare unto men that they be nothing worth. They also that serve them are ashamed: for if they fall to the ground at any time, they cannot rise up again of themselves: neither, if one set them aright, can they move of themselves: neither, if they be set awry, can they make themselves straight: but the offerings are set before them, as if they were dead men. . . . For how can they be called gods? because women set meat before the gods of silver, gold, and wood. And in their temples the priests sit on seats, having their clothes rent, and their heads and beards shaven, and nothing upon their heads. They roar and cry before their gods, as men do at the feast when one is dead. . . . And ye shall know them to be no gods by the bright purple that rotteth upon them: and they themselves afterward shall be consumed, and shall be a reproach in the country. Better, therefore, is the just man that hath none idols: for he shall be far from reproach."

And now over the great mound of Beisan, where the roaring and crying of the temple priests no longer resounds, there daily floats across the still air from the village mosque the call to prayer:

"God is the greatest. God is the greatest. God is the greatest. God is the greatest. I testify that there is no god but God. I testify that there is no god but God. I testify that Mohammed is the Apostle of God. I testify that Mohammed is the Apostle of God. Come to prayer. Come to prayer. Come to success. Come to success. God is the greatest. God is the greatest. There is no god but God."

For the worship of the "Fierce Devourer" and the "Queen of Heaven" has long passed away, and that of the God of Islam and of Israel reigns supreme.

THE MAZZEBAH OR SACRED COLUMN.
The position which this column occupied in the temple may be seen in the view on page 139. It consists of a cone-shaped piece of basalt set on foundations.

* Charles, *Apocrypha, etc., of the Old Testament*, i, pp. 600-611.

The New Star in Pictor Becomes a Double Star.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

Some weeks ago the surprising announcement was made that a star had split into two. "Nova Pictoris" is not visible in our hemisphere, and various theories—fantastic and otherwise—have been advanced to explain this occurrence. Dr. Crommelin here recounts the discovery and history of the star, and its latest behaviour.

On 25th May, 1925, a new star was detected by Mr. Watson at Beaufort West, South Africa, some 10° south of the brilliant Canopus, and therefore quite out of reach of European observers; it was the fourth bright Nova of the century; the others were Nova Persei in 1901, Nova Aquilae in 1918, Nova Cygni in 1920. The star of 1925, known as Nova Pictoris, resembled the others in having been previously present as a faint star (in this case of magnitude 13), as was found on the examination of photographs taken before the outburst; but it differed from them in its more leisurely ascent to maximum; it is reported in *Harvard Bulletin* No. 823 that the star had already attained the third magnitude six weeks before its detection. It did not, however, reach its maximum light till fifteen days after its detection; moreover, there was a second, slightly higher, maximum some weeks later, and the decline was also leisurely, so that the star was still plainly visible to the naked eye at the end of 1925 (magnitude 4½).

An Immeasurable Distance.

Nova Pictoris was at a greater distance from the Milky Way than most new stars, the distance being 24°; however, Nova Coronae of 1866 was twice as far away; that last was probably nearer to us than other Novae. Nova Pictoris is too remote for its distance to be ascertained by direct measures of its annual parallax. Attempts have been made to find its distance by the spectroscopic method, but the applicability of that method to Novae is rather questionable, and in fact very discordant results were obtained. Thus Mr. Davidovich found a distance of 540 light-years, while Professor Hartmann gave a value nine times as great. I regard the smaller distance as more probable; it would make the real light at maximum comparable with that of other Novae, while Hartmann's value makes it very much brighter.

The determination of the proper motion is of importance, in view of the star becoming double. Fortunately photographs were obtained twenty-four years ago with the Bruce lens of 24 inches aperture, which was then at the Harvard Observatory Station at Arequipa, and is now at the Boyden Station, Bloemfontein. The recent plates were taken before the detection of the star's duplicity, and no mention is made of duplicity on the old plates; but it must be remembered that the images of stars on photographic plates are generally several seconds in diameter, so that the images of two adjacent stars would probably be blended into one. The motion which Miss C. D. Boyd has derived from these plates is 0.042″ per annum towards the west, and 0.018″ towards the south, giving a total motion of 0.046″ in position angle 247°. It will be remembered that the zero of position angle is towards the north, and it is reckoned in the opposite direction to that of a clock face; that is, east is 90°, south 180°, west 270°. The Johannesburg telegram of 28th March gave the position angle of the line joining the two components as 70°, which is in almost the same line as that of the proper motion; a matter of some importance when we try to explain the duplicity.

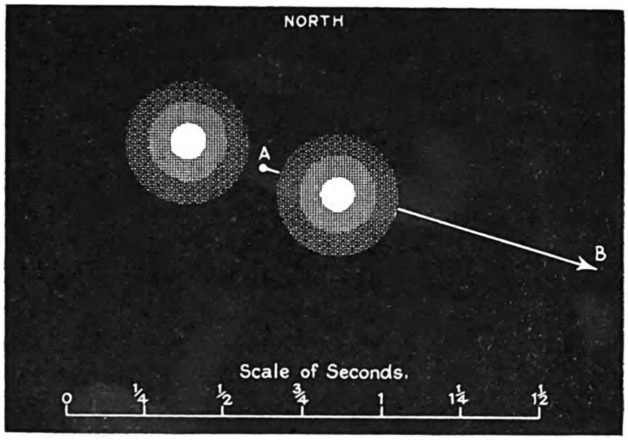
Dr. J. Lunt of the Cape Observatory made a most careful study of the spectrum of the Nova, and the changes in it during the first year after the outburst; this is described in the Monthly Notices of the R.A.S. for May, 1926. He notes that for a time astronomers had been unwilling to accept the interpretation of the very great shifts of the spectral lines in Novae as being due to rapid motion in the line of sight, but that they are now returning to this view. He quotes Professor Hartmann's sensational telegram to *Astronomische Nachrichten* with reference to Nova Pictoris, "Nova problem solved; the star swells up and bursts." The idea here is that some unknown cause made the interior of the star much hotter than usual, causing rapid expansion. The outer layers would be pushed outwards, without themselves suffering any great increase of temperature. Thus there would be an increase of light through the greater size of the disc, but at first no great change in the spectrum; then followed what Dr. Lunt describes as an "explosive outburst"; he suggests that this may have arisen from the diminution of pressure in the star's intensely hot interior, owing to the removal of the superincumbent layers.

Dr. Lunt gave the rate of increase of the star's diameter as 330 kilometres per second; this would

produce a disc equal in size to the orbit of Neptune after the lapse of five months; he anticipated that it would take somewhat longer than this for a visible nebulous disc to form. Such discs were seen in Nova Persei, in Nova Aquilae of 1918, and in another Nova in Ophiuchus in 1919. The nebulous ring round Nova Persei is not to be confounded with the much larger nebula photographed round the star in the autumn of 1901, which was rendered temporarily visible by the light of the great outburst of the star. That nebula may possibly have been the result of a former outburst of the star centuries earlier.

Actually a small nebulous ring was observed round Nova Pictoris last autumn; details are given in Harvard College Observatory *Bulletin* No. 856. Suspicions of such an envelope were aroused by photographs taken in October, 1926, at Arequipa. They could not be verified at that time, as the Observatory there was moved to Bloemfontein. Early in the present year the ring was photographed, being narrow, well defined, and of small density; it was proved not to be a photographic illusion by the fact that neighbouring stars of the same magnitude showed nothing of the kind. Professor Hartmann also photographed it at La Plata, and gave its diameter as one second.

The next development was the observation by the La Plata observers, about 26th March, 1928, that the appearance of the ring had altered. They at once telegraphed to the Union Observatory, Johannesburg, asking that it should be observed with the large refractor, of 26 inches aperture, which has lately been erected there. Mr. Wood and his assistants at once noticed that the star now appeared double; there were two rather ill-defined nebulous discs, of the same magnitude and appearance; each was about

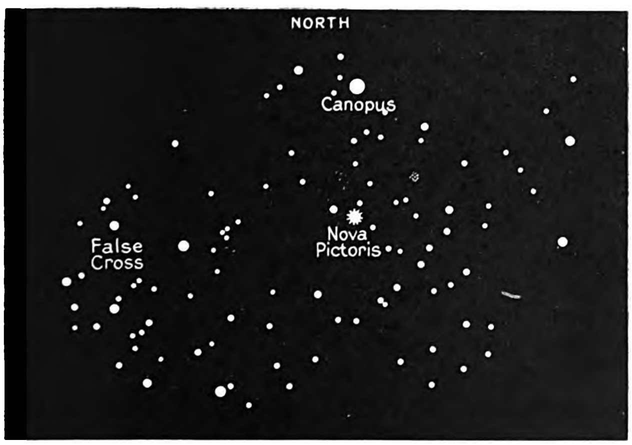


APPEARANCE OF NOVA PICTORIS ON 28TH MARCH.

Diagram, specially drawn for *Discovery*, showing appearance of Nova Pictoris as a double nebulous star, according to the Johannesburg telegram of 28th March, 1928. Distance of centres, half a second. Proper motion in twenty-four years 1.1 seconds, that is from A to B, which would be the motion of the centre of gravity. The line joining centres is in position angle 70°, the proper motion angle 247°.

0.40″ in diameter; their centres were about 0.50″ apart, and there was a narrow darker band separating them. On the other hand, Dr. Spencer Jones, His Majesty's Astronomer at the Cape, gave the distance between the stars as only 0.20″. The Johannesburg estimate of the distance is probably to be preferred, as their telescope is larger, and the observers there have had much practice in measuring difficult binary stars.

If the star really divided into two portions, the division must obviously have taken place some time before the duplicity was recognized. Taking the smaller estimate of the star's distance from us (540 light-years), half a second in angular distance means a real distance between the stars nearly three times as great as Neptune's distance from the sun. If they separated at the rate of a hundred miles a second the separation must have taken place about three years earlier, or about the time of the original outburst. The fact of their not being seen double earlier merely means that they were too close for our telescopes to separate them.



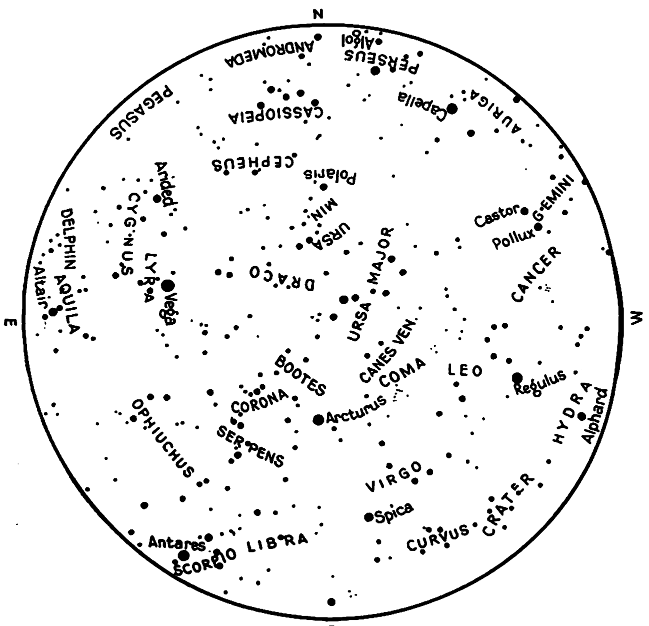
NOVA PICTORIS AT ITS BRIGHTEST.
This shows the appearance in July, 1925, soon after its detection, when Nova Pictoris was a first magnitude star.

The theory that Novae arise from some kind of collision has been suggested by many people; some suggest collisions between star and star, others between star and nebula, others between star and planet. In the present case the fact that the two discs are closely similar to each other suggests that if any collision occurred it was between two similar bodies, that is, between star and star. This is the theory that Mr. Bickerton has vigorously upheld for over forty years; but most astronomers think that there are far too many Novae for this to be the general explanation of them. From the known sizes and distances of the stars, there would on the average

be only one collision in many million years, whereas we observe more than one Nova per annum when faint telescopic ones are included.

However, Nova Pictoris differed sufficiently from the average Nova to make it possible that it had a different origin from them, and in fact Dr. Spencer Jones, in a communication published in *The Times* of 29th March, appears to have viewed with favour the suggestion that there really had been a collision of star with star in the present case. If that was so, there is one point which differs notably from Mr. Bickerton's theory; he laid great stress on the fact that the portions of the two orbs that came into impact would coalesce to form a "third body" between the two stars, and that this body would for a considerable time be much the hottest and brightest body in the system. But the Johannesburg telegram of 28th March, if correctly interpreted, stated that the middle point between them had the appearance of a darker band, so that there seems to be no third body in the system. The outburst might perhaps be explained by two stars making a near approach to each other, each raising very high tides in the other. These tides might relieve the pressure in the interior of each star, and so indirectly produce the great increase of light.

An article in the *Observer* for 8th April suggested that the two colliding stars might both have been dark ones; this, however, is negatived by the fact that a star, of magnitude 13, was seen on photographs taken twenty-four years before; the same article suggested that the stars rebounded after collision, as though they were India-rubber balls. It seems to me utterly improbable that stars could behave in this manner.



STAR MAP FOR MAY.
The face of the sky as seen from London at 14 h. sidereal time (not summer time), 6th May at 11 p.m.; 22nd May at 10 p.m.

Two stars, the mass of each of them being equal to that of the sun, would pass each other with a speed exceeding 600 miles per second; but this speed would quickly diminish as they receded, owing to their mutual attraction; it is impossible to make an exact calculation without knowing the original speed of each star, as distinguished from that produced by their attraction. Supposing that a separation of half a second has occurred in two and three-quarter years, that gives an average separation of ninety miles per second, if the distance is 540 light-years.

The Future.

This is a reasonable amount; that in the first year would have been more rapid, and the present rate would have fallen to perhaps one-third of the above average rate; still, the outward motion ought to be manifest in the course of the next few months or years, and speculation is a little idle until we have more facts about the relative motion. It may be pointed out that if the present duplicity is due to a single star having split into two portions, their future career will depend on whether the rate of separation was greater or less than the parabolic velocity. In the former case they will recede from each other indefinitely; in the latter case recession will sooner or later be turned into approach, and the stars will meet each other again; but as they will probably have then expanded into large nebulous bodies, the meeting will be under conditions very different from those at the time of separation.

I conclude with the remark that while astronomers are pleased at seeing such a large amount of popular interest in this occurrence, they would be still more glad if the interest were a permanent one. There are countless marvels continually present in the heavens, but these attract little public interest; whereas anything of a bizarre nature, even when relating, as here, to a pair of faint telescopic orbs far out of reach of European observers, produces flaring headlines in our newspaper placards, and occupies many columns of text in the papers.

POSTSCRIPT:—A further telegram from Johannesburg reached Copenhagen on 14th April. It announced that a ring three minutes of arc in diameter now surrounds the Nova, and that two inner rings have also been photographed. These rings are too large to have been projected from the Nova at the time of the outburst. Presumably they were there before, and are now rendered visible by the light of the outburst reaching them.

The Birth of a Bird.

By F. B. Kirkman, B.A.

Everyone delights in Spring at the nesting birds, but how many of us believe that the chick breaks the egg with its beak? Chickens and pigeons have long been studied, but observation is wanted on wild species.

MUCH has been written about the development of the bird inside the egg, its embryonic life, but of its manner of exit from the egg relatively little is known, and this little chiefly concerns the domestic hen and the domestic pigeon. For the most complete account of the birth of the former we have still to go back to Réaumur's "Oiseaux Domestiques" (Mémoire VI), of which the first edition was published as long ago as 1749. An abstract in English of his results is to be found in a little book published in 1833, the "Domestic Habits of Birds," by J. Rennie. Réaumur's observations have been supplemented in recent times by Mr. F. S. Breed.* If to these be added Mr. W. A. Craig's† notes on the pigeon (*T. risorius*), we appear to have exhausted the literature of the subject as far as domestic species are concerned. Of the hatching of wild species there is no detailed account, although W. H. Hudson has left us in his "Naturalist in La Plata" a short but interesting note on the subject, to which we shall return.

What follows relates exclusively to the chick of a wild species I have studied for several years, the blackheaded gull (*Larus ridibundus L.*), the commonest of British sea-birds. It is the little red-legged, red-beaked bird that has in recent times made itself so familiar as a winter visitor to the parks and quays of London and other riverside towns. In summer it goes to breeding places, usually far inland, by the margin of lake, or loch, tarn or bog, and in some of these places it may be found congregated in thousands.

Cracks in the Shell.

Like the domestic fowl, the blackhead makes its nest upon the ground (Fig. 1), but is content usually with three eggs. Its chick, again, resembles the domestic chick in being covered with soft thick down, but differs from it in its colouration, which is usually some shade of buff or brown, more or less thickly spotted with black (Fig. 2). To a large extent, it resembles it also in its performance of the complex series of acts to which we now turn.

If towards the end of the third week of incubation, the eggs in a blackhead's nest be examined, there will be found on the surface of one of them an area of light cracks. This area extends until it occupies about a quarter of the circumference of the shell at its bigger end. If the egg is put to the ear, a rhythmic tapping is clearly audible. The rhythm varies from single taps to double, and some are stronger than others, but the impression left on the mind is that the process is automatic, like pulsation. One hears also a repeated cheeping, which makes it evident that the chick has already penetrated the inner shell membrane dividing it from the air-chamber provided by nature at the bigger end of the egg, and that it has begun direct lung breathing. After thirty or forty hours or so, the persistent tapping on the inner surface results in a small, clean cut hole being drilled somewhere in the cracked area (Fig. 2). I have records of it in the centre, on the right-hand, on the left-hand, and toward the top. Through this hole the tip of a moving beak is visible.

An Opening Lid.

After a few hours more, either a second hole is made, about half an inch to one or other side of the first, or else the latter is greatly enlarged (Fig. 3). If two holes, these are joined after a time by a simple fissure or split in the shell. Whichever form the breach takes, it extends roughly the width of the cracked area. That suffices. The tapping ceases, and is succeeded by periodic thrusting movements made with the whole of the chick's body. Their effect is to extend the split or hole both ways round the big end, and at the same time to force this end back, so that it becomes an opening lid depending upon a gradually narrowing hinge. A final thrust and the chick is free.

There we have in outline the process of hatching viewed from outside. The details of its mechanism have now to be described, and these differ with the two main phases into which the process divides itself.

The first phase is the making of a breach in the shell by tapping. It is well known that the instrument used for this purpose by all birds, and also by reptiles, including the crocodile, is the so-called egg-tooth. In birds it is a small, upward, peak-shaped projection on the tip of the upper mandible of the beak. It

* "Instincts and Habits of Chicks." 1911-12. In the *Behavior Monographs* published by Holt.

† *Journal of Animal Behavior*, II, 1912, 296-8.

appears a few days before birth and, having performed its unique function, disappears gradually after the chick's exit from the egg. Its position on the top of the point of the beak implies that the taps are upward movements. I was not surprised, therefore, to see upward movements when I broke away the shell at the spot where the tapping occurred. The same fact has been noted by Mr. F. S. Breed, in the case of the domestic chick. It is a fact that disposes of the popular notion that a bird pecks a way out of the egg in the sense of striking forward with the end of the beak. Occasional pecking movements, have, it is true, been recorded. "At times," Mr. Breed writes of the domestic chick, "before the egg has been broken in two, one does see short, quick, forward thrusts of the bill, followed by working of the mandibles. And chicks, only a few hours out of the egg, may be observed repeatedly executing what might be called a pecking reaction 'into the air,' followed by a clapping together of the mandibles."

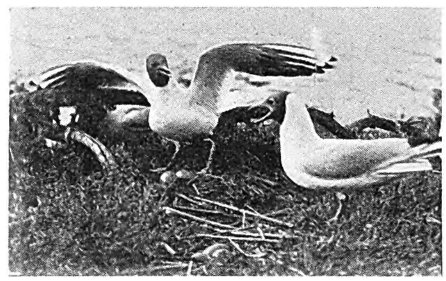
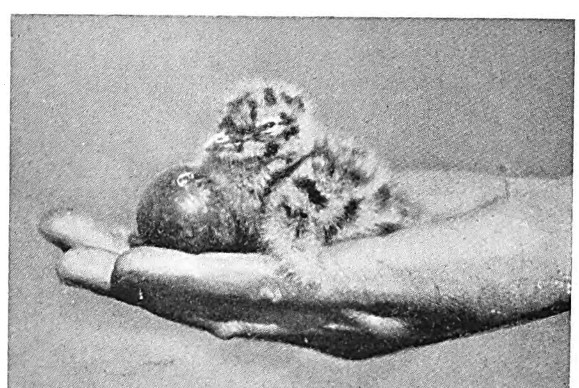


Fig. 1.
BLACKHEADED GULLS AT THEIR NEST.

In the case of the blackhead chick, I have heard occasional taps that had a sharper sound than the usual. These may have been made with the tip of the beak, and were possibly the accidental result of the bird's movements as it shifted in the egg. Also, after the chick has effected its release, I have observed opening and closing movements of the beak, which may be the same as the "pecking reaction" described above. These movements are interesting and puzzling, but they have little or nothing to do with the perforation of the shell, which is obviously the function of the sharp-pointed egg-tooth.



[Photographs by F.B.K.
Fig. 2.
BLACKHEAD'S EGG AND CHICK.
The first hole drilled through the shell by the egg-tooth of the bird inside is here shown. The chick differs in colouration from the domestic fowl.

On breaking away the shell I found not only that the movements of the beak are upward, but also, as indeed the rhythmic tapping had led me to expect, that they are automatic; they seemed to me to be clearly part and parcel of the strong pulsation of the whole body, due presumably to the onset of lung breathing and blood circulation. Each tap is one with each throb of the body. Thus the perforation of the egg is an involuntary act; the chick is not trying to make a breach; on the contrary, its achievement results automatically from the pulsation of its body in the sense that this pulsation is the sole source of the motive power or energy that keeps the egg-tooth tapping on the inside surface of the shell. Whether this is true of the domestic chick, the pigeon, and of wild species generally, remains to be ascertained. If it is true, it provides a remarkable solution of the problem of exit, a solution involving the utilization of the throbs of the chick's body to drive a highly specialized tool, the egg-tooth, devised by nature *ad hoc*.

The first phase of the blackhead's exit ends when it has made a fissure in the shell extending about a fourth of the way round the larger end of the egg. Herein it differs from the barn chick and duckling, also from the pigeon as observed by Mr. Craig. All three extend the line of cracks nearly round the circumference, the direction, as noted by Réaumur in the case of barn chick, being from left to right: "il fait sur son propre corps une révolution de gauche à droite." It does this also in the rare cases when the fore end of its body is lodged in the small end of the egg. The blackhead appears to proceed in either direction; that is to say, I have found the second hole it perforates, either to right or left of the first (Fig. 3). The distance it moves is, of course, relatively small.

Réaumur asked himself whether the chick shifted round from left to right with the aid of its beak or its legs. He assumed it must be one or the other. As he could not devise any way of determining the part played by the legs, he turned his attention to the beak. He removed the shell along a portion of the line the beak was to travel; thus ensuring that it would strike air. If it struck air only, and

the chick still progressed to the right, then the inference would be that the beak played no part in its progress. Both the two chicks experimented with progressed beyond the prepared fracture, and proceeded with its extension. Réaumur concluded that the turning movement was effected by the legs. What remains to be known is the stimulus that impels the chick to effect the turning movement.

The second phase in hatching lies between the completion of the work of the egg-tooth and the final exit. During this phase the blackhead chick, as already stated, is making periodic thrusts, the effect of which is to push the big end or cap of the shell outward, and so open the way to release. What is the mechanism of these thrusts?

If one examines the chick in the shell, one finds that it is in a very curious position. It lies with its head and the fore part of its neck curved down under the body, its throat facing its stomach, and not only so, but the head is, as it were, bolted into place by the beak, which passes upward between the right arm (wing) and the side of the breast. This position I found, after making my investigation, corresponds exactly to Réaumur's description of that of the domestic chick: "Il est presque mis en boule; son col en se courbant descend du côté du ventre, vers le milieu duquel sa tête se trouve placée; le bec est passé sous une des ailes . . . ; cette aile est constamment l'aile droite . . . "

Fig. 3.
BLACKHEAD'S NEST WITH TWO EGGS.
This gull nests on the ground and usually lays three eggs. One of those illustrated above shows two holes made by egg-tooth. After a time these become joined by a split in the shell.

The effect of the blackhead chick's position is that its spine forms an arch supported at one end on the legs, and at the other on the back of the neck and head, as shown in the diagram which corresponds generally to those of Réaumur (Fig. 4). The thrusts appeared to me to be upward thrusts of the spine, and it is easy to understand that they are very powerful, seeing that they have behind them the double leverage of the muscles of the legs and of the back of the neck. According to Réaumur the domestic chick thrusts the body forward, not upward, and it does so by means of the legs. This one would expect, for it has not, like the gull chick, to extend the fracture, but only to push out of the way a cap or lid already nearly detached from the body of the egg.

Here again, as in the case of the taps of the egg-tooth, there is reason to think that the achievement of release from the egg is not what moves the chick to action. Its movements at this stage seem to be directed solely to the more immediate object of freeing its head, the physical stimulus being no doubt supplied by the increasing squeeze of the head between the growing body on the one side, and the inside of the shell on the other. It is not a posture that any animal would be likely to tolerate indefinitely.

The first act in the process of release may be called that of unbolting; in this, the blackhead chick, after long efforts, manages to release its beak from between the wing and the flank. Here one may well demand what purpose this peculiar position of the beak serves. It probably adds force or backing to the upward tapping of the egg-tooth, for this, of itself, can hardly be very effective. Réaumur goes further and suggests that the blows are guided by the wing and body.

Once the beak is released, the withdrawal of the head from under the body is relatively simple. It is effected by a sudden and violent jerk, extremely difficult to follow; one moment the head and neck lie pressed between the chick's under-parts and the shell; next moment they are stretched out in front, and the exit from the egg is thereby practically completed. No such sudden or violent movement was observed by Réaumur of the domestic chick: "it draws its head from under the wing, stretches out its neck . . . "

The exit, as far as the blackhead is concerned, is not the end of the tale. Almost as soon as clear

of the egg, the chick continues periodically to repeat the thrusting movements, though their purpose has been realized. The movements are now more easily observed: both the powerful arching of the spine, which seems to some extent independent of the leverage of its supports; and also the upward push of the legs. A few of the thrusts end in the chick visibly moving *backward* an appreciable distance; these may represent part of what takes place in the egg when the head is released, with the difference that, the backward movement being met by the shell, there is no regression, but possibly a lift of the front of the body sufficient to permit the release. Occasionally I have seen the chick get its head again under the body, and again free it by an instantaneous jerk, still difficult to follow. These curious post-natal movements go on for some time. I have noted their occurrence not less than three-quarters of an hour after birth. They provide an interesting example of a reaction taking place, though its external stimulus has ceased to be operative, and continuing to do so, apparently in obedience to some law of periodicity.

It remains to be added that the chick just out of the egg is a wet, miserable-looking little creature, cheeping as it lies, and far from attractive, except for the bright eyes, across which, at instants, there passes, like the shutter of a camera, the third eyelid or nictitating membrane, with which everyone who has to do with birds becomes familiar.

The whole process from the first light network of cracks to the final exit, takes about forty-eight hours, a figure that is a rough approximation only, for I was unable to get exact estimates. The period varies no doubt from chick to chick. According to Réaumur the time between the making of the first hole by the domestic chick and its exit varies from one to forty-eight hours! Some chicks, he says, work continuously, others intermittently. He ascribes this in part to variations in the thickness of the shell. I have myself found a partridge egg so thick that it was impenetrable; the chick lay dead inside. Another two or three hours more of wind and sunshine are needed to make the chick resemble the contented downy little bird shown in Fig. 2.

It would be of great interest to have records of the hatching of chicks of other wild species. That they will show considerable differences is likely. An indication of this is provided by the fact related by W. H. Hudson, to which allusion has already been made. He was holding in his hand an egg containing a chick of a South American jacana (*Parra jacana*), a species of plover, and therefore a member of the same Order as the gulls. The shell was already chipped. All at once the egg parted, and at the same moment the young bird "leaped" from his hand and fell into the water, where it at once began to swim. On reaching land, it hid itself in the grass. Here we get behaviour strikingly different from that of the domestic chick and the blackhead chick. Neither of them would be capable of such activity for some time after their release from the egg.

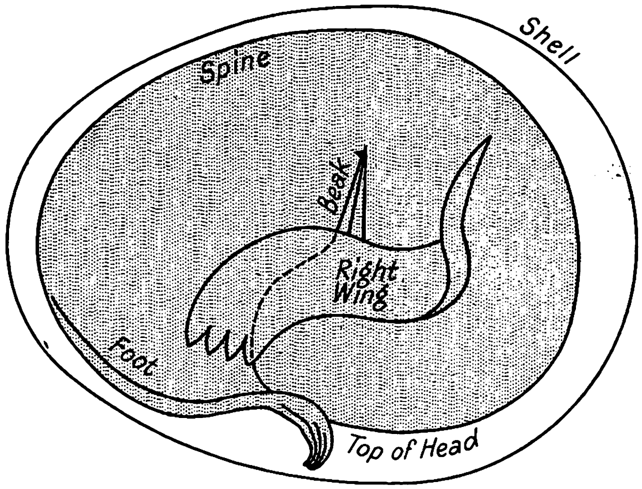


FIG. 4.
POSITION OF THE CHICK IN THE EGG.
This diagram represents the position before hatching. The spine forms an arch supported at one end on the legs, and at the other on the neck.

Hudson thought that the baby jacana's sudden exit was the effect of the anxious screaming of its parents. This is doubtful, judging from a somewhat similar incident recorded by Mr. R. T. Moore in the "Auk" (1912, p. 218). It relates to another species of plover, the least-sandpiper (*Pisobia minutilla*) found nesting by him on the Magdalen Isles, in the Gulf of St. Lawrence. The egg "broke open violently, as if by explosion, the two sections shooting to opposite sides of the nest." The chick celebrated its exit by a vigorous exercise of its wet arms (wings), one of which, striking the smaller section of the shell, sent it flying. Any further activity was suppressed by the parent bird, which proceeded once more to brood regardless of the figure bending over its nest.

We have here, as probably also in the case of the jacana baby, a seemingly normal hatch. What distinguishes both plover chicks from the chicks of the barn-fowl and the blackhead is their greater precocity; they are born with a much freer use of their limbs. What makes their manner of exit seem abnormal is its suddenness; but this suddenness becomes intelligible if regarded as an effect of the precocity. It is more than probable that the degree of precocity of the nestling at birth is the main factor determining specific differences in the hatching process.

Correspondence.

THE PROBLEM OF ABNORMAL AUDIBILITY.

To the Editor of DISCOVERY.

SIR,

The article in your April issue by Mr. Britton on audibility at a distance, and zones of silence, is most interesting. But I raise the question whether it answers to mathematical facts. The argument is, that because sound-velocity increases with the temperature of the air, and that temperature has been found to increase above seven miles (the minimum temperature height), therefore the direction of a sound will first bend upwards till it reaches the limit of seven miles, and then bend back more and more till it finally reaches earth again. Now this might happen if the sections of air were wedge-shaped as to produce a prismatic effect; but I do not see how it could happen if the air is stratified in strata of hot and cold. It is an elementary theorem that if a beam is refracted through a succession of media, the total change of direction will be the same as if it had passed direct from the first medium to the last. This shows at once that the total bending cannot exceed that produced by the beam of sound passing from air of earth-temperature to air of the highest temperature that we can imagine prevails at any height. But in any case the bending would still be upward, so that no amount or complication of refraction could possibly result in an earthward direction.

I suggest that it might be more to the point to inquire whether the beam of sound may be *reflected*. Energy cannot be lost. And if a beam of sound is a transference of energy along and in air, what happens to it when it reaches the confines of the air? It cannot simply cease. We might along these lines obtain the explanation of the return of sound, but not by refraction.

But there is another problem Mr. Britton does not refer to, and that is the dying away of sound at short distances. He passes over this as apparently "normal" inaudibility. But if this is "normal," *i.e.*, due to the necessary faintness owing to distance, how does his theory of refraction through an immense curve do anything towards explaining the "abnormal audibility" at much greater distances? Going up to heaven and coming down again in that sense will not effect any improvement in the direction of audibility. Thus his article neither explains the direction of the beam nor its effects.

I suggest that if it can be shown that the beam is returned by some method then the silent zone might be one of "interference."

Yours, etc.,

St. Nicholas Vicarage, Durham. WESTLEY BOTHAMLEY.

To the Editor of DISCOVERY.

SIR,

Mr. Britton's article on "Abnormal Audibility" brings to mind an incident I noted during the war which is not altogether unconnected with this question. It seems that under certain conditions, which I have not been able to determine, a solid body acts as a sounding board, and renders an inaudible sound perfectly audible within a certain radius of that body.

About the middle of 1916 I was stationed for a few weeks at Gravesend Barracks, and at one end of the parade ground there is a brick wall about seven feet high. I noticed one evening, that when standing quite close to the wall, the sound of gunfire in France was perfectly audible, but upon moving away from the wall not a sound could be heard. I cannot now remember the exact distance at which the sound became inaudible, but it is safe to state that it was a matter of about four feet at the most. The probable cause is that the much weakened sound waves upon striking the face of the wall were reflected off, possibly along their own path, and were thus strengthened up sufficiently to be heard within a very short distance of the wall; but both the incident wave and the reflected wave were far too weak to be heard without being somewhat enhanced.

Yours faithfully,

St. Mary's College, Middlesborough. JOHN L. A. SILLEM.

Mr. C. Britton writes:—

"In his comments on my article, Canon Bothamley assumes that the stratification of the atmosphere as regards temperature is necessarily in horizontal planes. This certainly need not be the case. I specifically pointed out that sufficient bending to secure the return of the sound ray would occur 'if circumstances were favourable.' If the stratification were slightly convex downwards at any point sufficient 'prismatic effect' would be obtained to produce the necessary amount of refraction. Any hypothesis based purely on reflection cannot explain the regions of silence. Interference cannot be invoked here as it only applies to the case of *continuous emission* of sound; the phenomenon cannot occur in the case of an isolated sound wave, such as an explosion."

APRIL HUNDREDTH ISSUE.

To the Editor of DISCOVERY.

SIR,

May I congratulate you on the success of *Discovery*. I hear on all sides of its wide appeal. I think that you have solved the problem of producing a magazine that is read in schools as well as by the general public.

Society of Public Analysts. C. A. MITCHELL.

Dr. C. S. Myers, F.R.S., Director of the National Institute of Industrial Psychology, writes:—

"I wish to congratulate you on the hundredth number of *Discovery*. I read it over the Easter holidays with the greatest pleasure and interest. To my mind the number is by far the best that has as yet appeared. I need hardly say how much I wish that the magazine may continue to increase in circulation and prosperity."

PAGAN FESTIVALS IN MODERN EUROPE.

To the Editor of DISCOVERY.

SIR,

Mr. Pryde-Hughes' letter in your March issue has suggested a possible means of supplying something of interest to him, and also of enabling me to recover two references which have eluded my memory for about twenty-five years. One is a work of Jankowski, bearing the title (if my recollection is correct) *Der Weihnachts Aufzug in Polen*; the other is by Sienkewicz, on the folk-lore of various animals and birds, including the bear, stork, raven, etc.

From the fact that my intermittent searches have been unsuccessful, it is possible that I have confused articles appearing in some publication with the title of books. In any case, I shall be very grateful for any information and particulars which may help to trace the articles mentioned.

Yours faithfully,

Banstead, Surrey. H. A. AUDEN.

People of the Great Plains—II.

By J. E. Pryde-Hughes, F.R.A.I.

Continuing from our March issue an account of post-war experiences in Hungary, the author here deals with conditions on the famous Puszta. Ancient customs of ethnographical interest are fast dying out.

East of the mighty bend in the Danube, the traveller descends on to the Great Plain of Hungary, the Alföld. At first through a richly cultivated territory, which becomes more sparsely populated and less cultivated, the way leads to the bare, wild moors of the Puszta. This is the home of the grey, wide-horned cattle, descended from the cattle brought in by Arpad's tribes over a thousand years ago, and of troops of untamed horses that sometimes number five hundred in a troop. Wild fowl, birds of prey—including eagles—flocks of sheep and wire-haired pigs, make up the other inhabitants of the Puszta. At one time wolves and such wild beasts made their homes there; they have now been wiped out, though recently during a hard winter small packs have come down from the hills. The moors are bleak and bare enough, and there are no houses or villages at all. There are a few mud-brick huts, or *Tanya*, but the plainsmen do not sleep in them; they wrap themselves in sheepskins and sleep under the stars.

One stands on the edge of this brown treeless monotone of parched pasturage, and speculates: life seems to end here. The lack of human sounds gives at first the impression of vast silence, but soon the ear attunes to other voices, to other and strange murmurings. Insects—and they are multitude in kind and number—give life to the thin grass; at a reedy, quaggy rain-pool frogs splash and reed fowl flutter, while cranes and storks stand on their stilts in the shallow waters, lazily catching breakfast. A parent stork rises heavily and flaps off to the nearest village, with a tasty bit for a youngster impatiently waiting at home on the top of some unused chimney. A faint whistle comes from nowhere; it is an unseen shepherd instructing his dog. In the blue above a lark spills "pearls of song" and stops—something dark brown floats leisurely overhead and hovers—then another and another, for there are hawks of various kinds; and far away the King of the Sky, an eagle, threatens the presentation of a scene from the inevitable "tragedy of the wild."

TYPICAL HORSEMAN OF THE PUSZTA.

These men tend the vast herds of horses and cattle which are bred on the plains. It will be seen that the saddle has no girth, so that when the rider is thrown he is not dragged by his horse, which has a rope bridle.

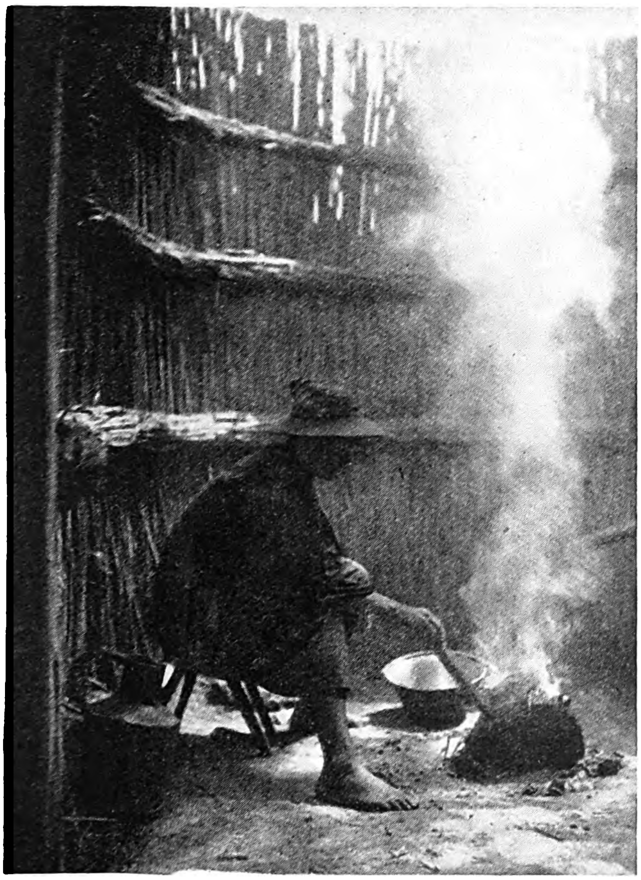
The plain is the home of the Csikosok, who tend the roaming troops of untamed horses, and year in and year out are rarely found seated on a stool or under cover. To live among them, the stranger should take a horse and everyone will greet him friendly. There is a secondary reason for a horse: the dogs of the shepherds and cowmen are shaggy, wild creatures, intolerant of strangers, and to go among them afoot and without ample protection is to invite an unpleasant fate. Fortunately the brutes cannot run very fast or far, as each has a rope collar with a piece of wood a foot long dangling from it, which taps the animal's knees and prevents his scurrying around and flurrying the flock.

As for the human inhabitants of the Puszta, they are splendid fellows—and handsome. I found a great pleasure in lingering to chat, and share with them their mid-day meal—a piece of fat bacon cured in *paprika*, a chunk of bread, and a large onion. It is

good—for the air and exercise on the plain make one hungry—and equally welcome is the *gulash*, or meat soup, which in various forms is always ready on the "hob," like the Welsh woman's tea.

I cannot say how many miles I covered over the Puszta, but the distances seemed interminable, with only the Delibab mirage that plays optical tricks on the horizon, and the mud huts at rare intervals to break up the space. As there is no timber on the plains—ignoring the few acacias planted round the huts for shelter—the fuel used is dried cow-dung, known as *belfa*, which may perhaps be translated as "belly-wood"—an allusion to its origin. This queer fuel is used for cooking purposes, not in the hut, but in a lean-to of rushes outside. Exactly speaking it is not a lean-to, but a survival of a primitive shelter, a relic of semi-nomad days when dwellings were not built for endurance but for the greatest temporary protection with the least amount of material and effort.

Tall rushes are bound together to make the walls, and the top is left open to the skies, the entrance being a mere "hole in the hedge." This is the original hearth of the ancient forebears of the plainsmen.



SHEPHERD PREPARING A MEAL.
The kitchen, a survival of a very primitive shelter, is made of tall rushes and adjoins the shepherd's hut (see upper photograph). The fuel used is dried cow-dung.

SHEPHERD'S SETTLEMENT ON THE PLAINS.
The hut, on the right, is thatched with reeds and has no windows, while the "kitchen" adjoining is open to the skies. The men sleep in the open and use the hut for storage purposes.

At the widest end is an open fireplace, a depression in the ground; over this on a crooked bough is hung the deep pan in which all the cooking is done. A few stools around the fire—to-day these have replaced the horseskulls originally used as seats—a roasting spit, some spoons and ladles stuck in the rush walls, a flat barrel-like vessel for holding water, and the furnishing of the "kitchen" is complete.

The *Gulyas-Tanya* is the hut of the cowmen who tend the wide-horned Hungarian cattle, descendants of those beasts which the migrating Magyars drove before them, or harnessed to their wagons, from the steppes of Southern Russia. This windowless, reed-roofed hut is like all the others, except where cowmen and horsemen work together; then there is one room for the Csikosok (horsemen) and another for the Gulyasok (cattlemen). It is not a place to live in, but it is a storehouse for food and the different belongings of the men; the wonderful greatcoats, the "suba" and the "szur" hang on nails in the walls.

Every man on the plain has one of each. The "suba" is a long coat without sleeves, or rather it has amputated sleeves—mere stumps which are sewn up and decorated with braid, just as if the wearer were armless. The garment is thrown over the shoulders and held in place by a strap across the chest. The outside is tanned leather, generally hand-embroidered, with blues and reds predominating, though sometimes blacks, and also little bits of coloured leather. The wool of the sheepskin lines the inside, and in this garment the herdsman sleeps under the stars, wrapping himself up as in a sleeping bag on chilly nights. The "szur" is a much more elaborate affair, for festivals. Not so long ago the men embroidered and decorated their coats themselves

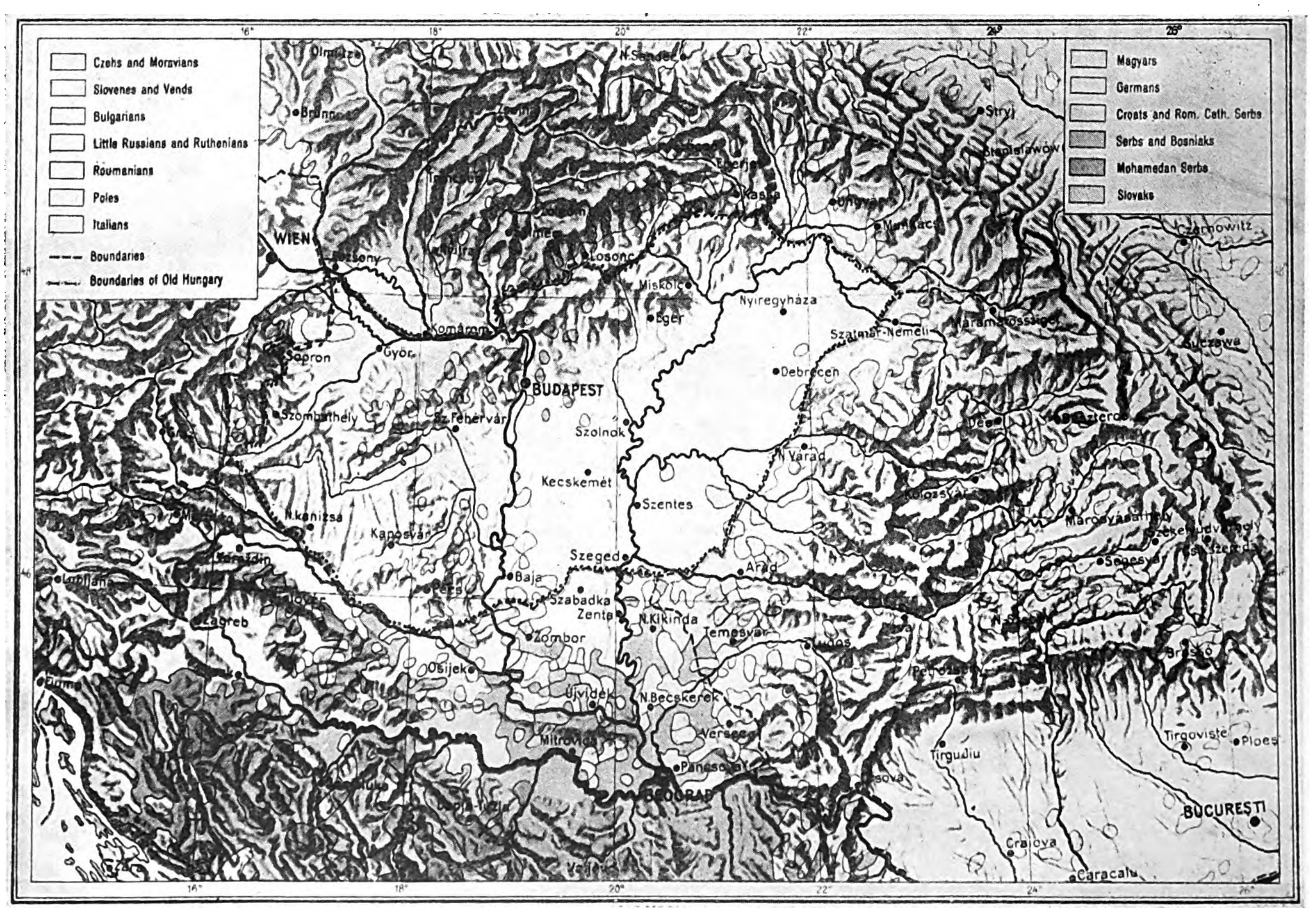
and made the simple articles and implements of their daily needs, but cheap and easily obtainable manufactures are unfortunately rendering this industry of the plainsmen unnecessary.

The "menes," or troops of horses, run wild on the plains with the Csikosok ever in attendance. It is wonderful to watch these fellows. Three of them generally handle a bunch of several hundred half-wild animals. On the move, one Csikos on each flank and one in the rear, they round up the horses into a troop and keep them going in the desired direction.

The water hole, however, is the great magnet which keeps the troop intact. As each troop is allotted a special section and well, the wanderers will always return; however, when a storm arises, the horses get uneasy, and a thunderstorm is responsible for most arduous riding. The Csikosok then have to dash round like madmen throughout the storm, keeping the troop turning in a circle so that a whirlpool action holds it together. Sometimes this lasts for hours; all the while the Csikosok must ride as for life, the great short-handled stock-whips cracking around the ears of the frightened animals, and the dust rising in clouds till only a swirling mass of life is dimly visible.

At night this task is fraught with grave danger. The Csikos has no saddle proper; it is the mere suggestion of a saddle—a piece of shaped cloth stuffed till it is a quarter to half an inch thick, a *numnah*, with the stirrup leathers attached. This is slung over the horse's back without girth or surcingle. It is quite unattached, and much practice and skill is required to mount. But the Csikos learns the knack in his infancy, and holding the apology for a saddle tightly to the withers with the left hand, he slings his leg across like an acrobat. To me it was an impossible feat, yet I saw the value of the arrangement: on this pot-holed land, in the dark especially, the wild riders come down frequently, but saddle comes away too, so there is no fear of being dragged among the troop and kicked to pieces.

In a bad season this sort of thing may happen frequently, and as the rains do not drain off quickly,



ETHNOGRAPHICAL MAP OF OLD HUNGARY.

The localities mentioned in this and the previous article are not usually found in modern maps. The natural mountain boundaries that surround the great plains of Hungary are now broken up politically. The frontier imposed by the Trainon Treaty of 1920, here indicated by the finely dotted line, has reduced the pre-war area from 326,000 to 92,720 square kilometres.

A SHEPHERD AND HIS DOG.
The dogs are somewhat dangerous to strangers, who are advised to travel on horseback. The vast expanse of the Puszta is here well illustrated.

dangerous stretches of marshland form, and bogged horses create an additional task for the Csikos. Sick horses, too, need his care, for he is concerned with the health of the animals in his troop. If there is any sign of illness which he himself cannot check, the affected animal is isolated and taken right across the plain to the veterinary surgeon. Such an event gave me a new insight into the character of the Csikos. Out on the Hortobagy Puszta we had run across a troop rounded up at a well. I took a photograph, and with the aid of my friend Söreghy, the young Debreczin archaeologist, I got into conversation with the chief Csikos, a man of few words but simple, courteous manners. His mount was nearer ten years old than five; its headgear consisted of a plaited string bridle, with a steel bit on a single ring, held in place by a wooden peg each side against a small disc of leather—a primitive, yet satisfactory contrivance. Round the animal's neck was looped the lasso.

The friendliness of the fellow encouraged me to suggest a few tricks with the lasso, and this was no sooner understood than the Csikos was on the ground with the lasso uncoiled, and in as long as it takes to tell, he had cut out three horses, bringing them one by one out of the troop. I learned later it was not chance work cutting out the three horses, for they had that morning been marked down as ailing and were later trotted off to the village miles away. It is extraordinary that these men recognize horses individually. From a troop of five hundred they will cut out a particular animal single-handed, but always, I noticed, the Csikos dismounts to use his lasso, which he wields with precision. It is perhaps easier to throw when standing, but the Csikos sometimes gets badly skinned when dragged along on the end of the rope by a refractory animal.

This day, too, we were to see the Delibab. Sõreghy had spoken so much about it the night before, that I had got it into my head that the phenomenon was a kind of will-o'-the-wisp. I was even innocent enough to call attention to a moving light in the inky darkness, which, however, turned out to be a shepherd, or someone, wandering round with a lantern.

As the sun gathered power, Sõreghy promised me the probability of Delibab manifestations about noon. I held my tongue, fearing there was some "leg-pulling" in process, but wondered how earth-gas was to be seen dancing around in broad daylight; I should have continued to wonder had not the term Fata Morgana been used and the mystery thereby dispelled. Before noon, however, when we were out in the centre of the Hortobagy Puszta, miles and miles from anywhere, the extraordinary mirage developed over the horizon. There appeared, as if standing on its head in a calm sea, a tiny church with trees surrounding it, and then again clumps of trees—always in this unruffled sea, and very clear-cut and distinct. The Puszta is a vast plain with scarcely any undulation, and nowhere a hill; the Hortobagy alone is something over a hundred miles in length from north to south. The soil is alkaline and is becoming more and more alkaline. When the lower layer of air gets hot—and it does so suddenly—one is treated to a characteristic of the desert, the mirage, or as the Hungarian plainsman calls it, the Delibab. Sometimes whole villages, which cannot be discovered even by telescope as they are below the horizon, float in the air, and groups of gigantic cattle and trees seem to sail in non-existing seas—all illusions, caused by the repeated refractions of light through the different air strata not being uniformly warmed.

CSIKOS AT WORK WITH A LASSO.
These Hungarian horsemen use the lasso in dealing with their herds—an art which they practised long before the American cowboy even existed.

Many fairy stories are woven round the Delibab: personified it is feminine, the daughter of the Puszta, wooed by the wind and the sun. Delibab loves the sun and flees before the wind; she shows her lovely face only when the sun shines and causes the mirage to appear to deter the wind which pursues her.

The geological foundations of the Puszta are the diluvial strata, and the few low ridges on the plain, which are scarcely to be detected, are accumulations of dust. The upper layer is of clay, and sand covers the clay. The soil is not suitable for agricultural purposes, and the pasturage is not in any way rich and luscious, except here and there round the pools and dead river swamps.

Bad Weather.

In dry weather the soil hardens like cement, but after heavy rains it becomes a sticky, treacherous mass, with pools of slimy water everywhere. This is a bad time for cattle and herders. Large tracks of ground are quite impassable, but it is worse still when hot sunshine follows rain; then it is positively dangerous to be abroad on the Puszta. The surface dries rapidly, yet underneath is a morass, so that there is a cement-like crust floating on a sea of mud. Animals sink through the crust, and can only be saved by the greatest exertions on the part of their guardians, while horse and man must step warily to avoid being bogged. As there is no firm ground on which one may get a purchase, extrication is a difficult task, and especially serious is the situation for the lonely rider, for he may shout for help all day without a soul coming anywhere within range of the loudest voice.

Before the regulation of the river Tisza the plain was studded with many more small lakes, ponds, and marshes, where wild fowl frequented in great swarms and found sanctuary. Some of these stretches of water still exist, and also the marshy ponds, but the Hortobagy river has ceased to flow. Spurned by its parent, with which it has now no connexion, this is but a long dribble of water, practically stagnant—an attenuated pond. Fishing has become a very tame affair as compared with the sport of former times when the flowing river was well stocked, and yielded good food to the plainsmen, who caught the fish with nets and by means of the ancient type rush-work traps. This quaint trap can still be seen, a maze into which the fish is drawn and from which it only escapes to make the acquaintance of the frying pan.

Though the atmosphere is dry, and except for exceptional spells comparatively little rain falls in summer, the climate is capricious—warm days are followed by exceedingly cold nights. It is frequently very windy, and then the dust is whipped up into sandstorms, which whirl steeple-high, stinging and cutting the face of the wayfarer so unlucky as to be caught away from cover, and nearly blinding the unwary.

I have mentioned that there are no elevations on the Puszta, but this is not quite correct. In certain parts there are a few scattered mounds, some from thirty to forty feet high and about 200 to 350 feet in diameter at the base. These are tombs, the work of man between the Neolithic age and the period known as that of the migration of the nations. When excavated in modern times nothing of account was found in them; a few odds and ends, mostly, I believe, of Avar origin, roughly dated the graves. Söreghy told me, however, with regret in his voice, that others had been before and had looted the resting-places of the early plain dwellers. The tombs have one value for the investigator: their presence proves that this waste, once abounding in game and fish, was inhabited by folk who probably pursued the chase, fished, and grazed cattle.

Monotonous hours and idle moments are many out on the plains, and the Csikosok and herders, denied all distractions, still whittle with their knives, cure skins, and weave myths. At meal times they sit round the big pan all armed with long-handled spoons which they dip into the gulash in turn, according to age and rank. Eating seriously, without talking, what do they think or dream? One rarely penetrates their mind—lonely and unread men have a natural suspicion of their thoughts. Perhaps they think of their work? Of the weather and the life around? I doubt it. I rather believe their minds turn back to the misty past, to the days of superstition and the birth of the myths and proverbs of the race.

The British Association.

It is announced that the King in Council has approved the grant of a Royal Charter to the British Association for the Advancement of Science. This new status as a body corporate will be of great value in enhancing the authority with which the Association brings to public notice many aspects of science; it will also be of legal advantage in regard to endowments, in particular for the custody of the home of Charles Darwin which was recently offered to the Association by Mr. George Buckston Browne. The many friends of the British Association will congratulate the officers on this Royal recognition, which follows closely upon the presidency of the Prince of Wales.

An Episode in the History of Geology.

By F. J. North, D.Sc., F.G.S.
Department of Geology, National Museum of Wales.

The recent discovery of a hitherto unnoticed paper by William Smith, the father of English geology, reveals his views upon some of the controversial matters at that time in dispute with Ecclesiastical tradition.

WILLIAM SMITH, son of an Oxfordshire farmer, and himself a civil engineer and land surveyor, is known, and rightly so, as the Father of English Geology. As a lad he showed an interest in stones and fossils, and as a man he used to advantage the opportunities, afforded during the course of his work in land-draining and canal-making, to study the peculiarities of the strata exposed at the earth's surface. He noticed that not only were the various layers of rock arranged in a regular order, one resting upon another, but also that the fossils of each layer were in some way peculiar to it; they thus enabled the various strata to be identified, when, owing to a covering of soil, or of rock, they could not be seen as continuous exposures from one spot to another, or when, having been locally washed away, as during the formation of a valley, they occur in discontinuous outcrops.

FIG. 1.
WILLIAM SMITH, LL.D.
A portrait at the age of 69, by Fourau, reproduced in John Phillips' memoir of Smith published in 1844.

Making use of these principles, he showed that the strata of the earth's crust were arranged in accordance with definite laws, and in 1815 he published a geological map of England and Wales on the scale of five miles to the inch. In addition to being the first true geological map, apart from some small manuscript maps of his own preparing, this laid the foundation of modern geological research, and became the basis of all later geological maps of this country, and the standard of geological maps for the world.

Smith's known writings deal almost exclusively with the practical application, in mining, quarrying, and civil engineering, of the important principles he discovered and enunciated, and he was, especially in his younger days, "remarkably disinclined to indulge in himself, or even to tolerate in others, mere speculation in Geology." This we learn from his nephew and pupil, John Phillips, who was also an eminent geologist, but it is apparent from his own writings as well.

The time, however, was one during which there was much discussion concerning the history of the earth's development, and during which geology was viewed with great disfavour by the Church, as being supposedly antagonistic to Scriptural teachings. Since Smith was a man who travelled much and attended many meetings, such as those of the Board of Agriculture, at which he met people interested in the progress of the new science of geology, it was difficult to believe that he could have formed no opinions concerning the matters that were so much discussed by his contemporaries, although hitherto practically nothing was known of the workings of his mind in that direction. It was known that he was in sympathy with the more advanced thinkers of his time, and rejected fantastic views like those of John Woodward and his followers, who claimed that the Deluge was the principal event in the making of the earth in its present form.* He considered that the Deluge was merely an episode in the earth's history, and that only the superficial gravelly and

* These views were discussed in *Discovery*, Vol. VIII (1927), pp. 118-122.

pebbly deposits that occurred beneath the soil in many places could be regarded as of "diluvial" origin. The idea that glaciers had once existed in this country, and that the superficial deposits were in many cases the result of the scouring and transporting action of ice, had not then been entertained—an illustration of the comparatively recent birth of some of the ideas that are now regarded as fundamental principles of geology, without which its whole fabric would collapse.

When the British Association met in Oxford, in 1832, Smith published a "Synopsis of Geological Phenomena," in which, for the first time, he expressed his views concerning the place of the deluge in the scheme of geology, but even this document only serves to illustrate—as will be seen from the extracts in Fig. 2—the line of reasoning by which he came to the conclusion that a Deluge had actually occurred.

The New Discovery.

A short time ago it was the writer's good fortune to discover a copy of another broadsheet published by Smith in 1835. It has not been noticed by any of those who have written concerning Smith's life and writings, and as far as can be ascertained it is the only copy now in existence. It owes its preservation to the fact that it had been bound up with a copy of the "Geology of Yorkshire" written by Smith's nephew, John Phillips, and formerly in the possession of John Edward Lee, who, although best known for his work on the Roman remains at Caerleon, was born in Hull in 1808, and was, in his earlier days, a companion of Phillips and an admirer of Smith.

The broadsheet is entitled "Deductions from established facts in Geology," and in addition to its interest as appearing three years later than the "Synopsis," which has hitherto been regarded as Smith's latest separate publication, it deals with the very matters upon which he seems to have maintained silence until reaching the age of sixty-six. There is no record of the circumstances under which the sheet was published, but it appeared in the year following Smith's retirement from active work, when he settled in Scarborough with the intention of completing the various investigations in which he had been engaged, and its opening paragraph suggests that he felt constrained to publish the "Deductions" in answer to inquiries that had been addressed to him upon the subject of the earth's early history. From certain remarks in it, there are reasons for supposing that it was in some measure a criticism of the "Principles of Geology," which Charles Lyell had first published in 1830, and which had been favourably received by many scientific people.

The sheet is too large to be conveniently reproduced here, but its general character may be indicated by extracts. It commences:—

"As doubts may remain in the minds of many of the Principles of Geology, I shall endeavour to exhibit the principles, long familiar to my mind, in a clear view, opened by the organized Fossils, which are the medals of Creation, the antiquities of nature, and records of time.

"It is certain that by the use of these in Geology we are carried back into a region of supernatural events . . . and see that in the Stratifications there have been Consecutive Creations and Destructions under water, which may be thus arranged."

Then follows the title, "Deductions from established facts in Geology." Smith recognized, first, a period during which the primitive rocks were formed, and when the earth was void of living things, followed by a period when stratified rocks began to form. It was at this juncture, he supposed, that living beings first appeared, and then for a time similar conditions prevailed, namely, the growth and death of living things, and the entombment of their remains in the sediments that accumulated on the sea floor.

The idea of evolution—that the living things of one period had necessarily descended from those of preceding epochs—had not then been seriously considered, and being aware that the fossils of the various rock systems were dissimilar, Smith concluded that, after a time, there commenced a "New order of things, essentially different from any 'causes now in operation,' distinguished by general destruction."

"Supernatural Changes."

The first created animals were destroyed by "a supernatural mode of extinguishing life," and they were replaced by a second creation, which was also destroyed, and replaced by a third, and that in turn by a fourth:—

"and so on successively by numerous alternations of stratification, numerous repetitions of new creations and destructions by which new species, genera, and families appeared, and others became extinct. Such changes as these which pervade this System must *each* be considered *supernatural*."

This was followed by "the cessation of the forming process—*a great supernatural event*" and the "First occurrence of DRY LAND, but in what period of time or in what manner it became dry we know not, nor have any data." Next came "THE CREATION—that of land Animals, the inhabitants of air, and most of those that inhabit the water, and the great variety of plants that clothe the Earth," followed by "The great *supernatural* event or catastrophe of THE DELUGE known by loose water-worn stones." "The Deluge," wrote Smith, "effected (by the agency of water) a most extensive destruction, evinced by bones mixed with debris. By these bones it is ascertained that there were land animals prior to the Deluge."

After the Deluge came a "CHANGE OF CLIMATE—ascertained by bones in the diluvium of cold climates, which belong to animals of a hot climate, and by an entire Elephant

SYNOPSIS OF GEOLOGICAL PHENOMENA.

SOURCES OF EVIDENCE.	DEDUCTIONS.	RESULTS.
By the remains of land animals mixed up with water-worn stones,	We ascertain that the	Earth was dry and inhabited.
By the boulder-stones everywhere scattered over the earth's surface,	There has been water in action.	
By the fossil shells in those boulders, identified with those in the stratified rocks,	We ascertain the way of action.	THE DELUGE.
By the height to which the boulders and sea-shells have been raised,	We get the force of action and height of the water.	

ILLUSTRATIVE EFFECTS OF THE DELUGE.

By alum-shale, organized fossils, those of coal, and mountain limestone, and boulders from all the rocks northward, in abundance,	The effects of a great current from the north are obvious on the Yorkshire coast.	The first rush of water was by sea from the North.
By the same,	with the like effects	Down the vale of York, from N.
By the absence of alum-shale fossils in the vale of Pickering,	Filey clift was not surmounted, which gives the height of	First rush of water about 200 feet.

FIG. 2.
EXTRACTS FROM W. SMITH'S "SYNOPSIS OF GEOLOGICAL PHENOMENA," 1832.

preserved in the Ice of Siberia—how effected we know not—seemingly a consequence of the Deluge."

Finally we have the "present order of things with a partially colder climate," a period during which animals are "successively renewed and destroyed in the order of nature."

The table is summarized in two concluding paragraphs. Smith deduced six distinct "orders of things" with five principal "supernatural events," and numerous "supernatural destructions." In his scheme,

"The Creation is the last, or principal one, of many preceding creations during the Earth's formation under water," and "The Deluge is the last of a long series of supernatural destructions."

The broadsheet is interesting as a record of a great man's thoughts, but it is still more so when considered in the light of contemporary geological ideas, for it shows how difficult it has always been to interpret facts aright when they are approached with a mind already prejudiced. Smith did not like to be unorthodox, and for that reason subscribed to views that, paradoxical as it may seem, were shown to be untenable by his own works, when their full significance came to be realized.

To appreciate the situation we must go back to the middle of the seventeenth century—the time of James Ussher, Archbishop of Armagh. By studying the chronology of the Biblical record he came to the conclusion that Adam lived about 4,004 years before Christ, and since, at that time, it was popularly supposed that the formation of the earth was an affair of six literal days, there arose a belief that the world was something less than 6,000 years old. The adoption of this belief had a retarding effect upon the development of geological ideas for nearly two centuries; for any attempt to explain the accumulation and deformation of rocks in so short a period, had of necessity to introduce supernatural convulsions, or to assume that all rocks were formed in the course of a few days in the condition and in the situations in which they now occur. Nearly all the eminent thinkers of that period were influenced by this belief, which gave rise to the fantastic "Theories of the Earth," to which reference has already been made.

Bitter Disputes.

Not only did Ussher's estimate retard geology, but it gave rise to long and bitter disputes. From 1701 onwards, the date 4004 B.C. was printed in the Bibles issued from the Oxford Press—by whose authority there does not appear to be any record—and this act, perhaps that of an over-zealous editor or printer, greatly increased the harm done by a wrong conception of Ussher's work, for the date came to be regarded as part of the Inspired Word, and before

many years had passed the facts relating to its introduction had been forgotten. This is reflected in the well-known lines in which Cowper, with characteristic mildness, protested against the assertions of those who, from the study of the rocks, were coming to the conclusion that the events which had resulted in the formation of the earth's crust must have required an enormously longer period than 6,000 years. He wrote, in "The Task":—

> Some drill and bore
> The solid earth, and from the strata there
> Extract a register, by which we learn
> That He who made it and revealed its date
> To Moses, was mistaken in its age.

The truth, however, must always ultimately appear, and as soon as men began to distinguish between the certain and the probable, and realized that the events of the past had been recorded in the rocks, the true story of the earth began to emerge, but it was inevitable that the supporters of the story should soon come into conflict with those who preferred the older, more established views.

The New School.

One of the first of the new school was James Hutton, an Edinburgh man, trained as a physician, but by preference an agriculturist. He, observing the action of rain, of wind, and of streams, upon the rocks around him, came to the conclusion that rivers make the valleys in which they flow, and that in doing so they transport material to the sea, on the floor of which it is spread out. In other words, as the surface of one land mass is worn away, the materials of a new continent are accumulating elsewhere. His views were first communicated to the Royal Society in 1785, and some years later appeared in an amplified form in his "Theory of the Earth, with proofs and illustrations."

Hutton taught the principle of uniformity in the operation of natural causes, and showed that the rocks of the earth's crust had been formed by the operation of the very processes that are at the present time engaged in modifying the earth's surface features. Thus arose a "Uniformitarian" school of thought in opposition to the Catastrophists, as the older opposing party came to be called, who saw in the hills and valleys, and the variously tilted rocks, the work of sudden convulsions, and of supernatural occurrences that accomplished the making of the earth in an incredibly short time. Such was the influence of "dogma" and "authority," however, that Hutton and his followers were bitterly reviled for making statements that we now regard as axioms!

If, as Hutton wrote, "The ruins of an older world are visible in the structure of our planet, and the strata which now compose our continents have once been beneath the sea and were formed from the waste of the pre-existing continents," the earth must be immensely older than 6,000 years—a period far too short for the destruction of so much rock and the accumulation of so much sediment. Indeed, he concluded that as far as visible nature is concerned, "we find no vestige of a beginning—no trace of an end," and the immediate result of the acceptance of Hutton's teaching was that geology came to be regarded as antagonistic to the Church, instead of, as was really the case, antagonistic only to certain dogmas which were based upon inadequate information and the attribution of unwarranted authority to Ussher's "date." The situation was rendered more piquant by the fact that many of the pioneers of geological research in this country—Michell and Sedgwick of Cambridge; Buckland, Professor at Oxford and Dean of Westminster; Conybeare, Dean of Llandaff—were prominent Church dignitaries. William Cockburn, Dean of York, was one of the leaders of those who protested against the new ideas, and almost piteously he asked Sedgwick:—

> "Are you convinced, after mature reflection, that you have discovered the truth? If you have satisfied your own mind, you may be able to satisfy mine, and thus to remove those doubts which make me at present fearing that you are leading many into error. . . . I persuade myself that you may not object to a friendly discussion on the subject. From my brother Dean (Buckland) I can hope for no such favour."

These words occur in the dedication of a book entitled, "A New System of Geology," which contained the substance of a paper read by the Dean at the 1844 meeting of the British Association at York. In it the Dean attempted to show that the whole of the present fabric of the earth's crust was formed and distributed in a few days, as a result of great volcanic outbursts upon the sea floor. The paper was not published in the Report of the British Association, but was subsequently privately printed, and copies are now extremely rare, but the arguments put forward by the Dean are so ingenious as to be worthy of special study.

A Prophetic Controversy.

The uniformitarian doctrine rested upon a foundation more solid than that of the school it was gradually replacing, and when Charles Lyell made it the basis of his "Principles of Geology," the dispute soon came to an end as far as those who kept acquainted with the advance of knowledge were concerned, although, in their enthusiasm, the uniformitarians were at first apt to claim more than

was justified by the information they possessed. This controversy, and the intensive research it provoked, laid the foundations of the modern view of continuity and evolution in the development of the earth and its surface features, and paved the way for the acceptance, a few decades later, of the idea of continuity and evolution in the realm of living things.

The reason for suggesting that Smith had Lyell's new work in mind when compiling his table of Deductions, is that he commenced with the remark that owing to doubts "in the minds of many on the Principles of Geology I shall endeavour to exhibit the principles long familiar to my mind," and, dealing with the periods of stratification, wrote of a "new order of things essentially different from any 'causes now in operation'—distinguished by general destruction."

The quotation marks enclosing 'causes now in operation' are in the original, and they are the only words so emphasized in the whole broadsheet. This would suggest that Smith was using what was, at that time, a familiar expression; and those are the very words which Lyell used in the alternative title to the first edition of his Principles:—

"Principles of Geology: Being an attempt to Explain the Former Changes of the Earth's Surface by References to Causes now in Operation." 1830.

The present title was not adopted until later editions appeared.

It is interesting to note that although in his earlier days Smith had no use for those who invoked "uncommon convulsions" to account for the earth's surface features, in his declining years he wrote of "a series of supernatural destructions," which not only gave rise to changes in the earth's conditions but, annihilating living things, had necessitated successive re-creations.

The explanation lies, no doubt, in the fact that in his retirement he was so intent upon developing his own views that he omitted to take into account the work of others. In the words of John Phillips, he "mixed too little with younger geologists to make the discovery that on the road which he opened were racers swifter than himself." He did not realize how great a part his own discoveries were to play in providing the means of solving the problems relating to the past history of the earth.

Little-known Orchids of Europe.

By T. A. Stephenson, D.Sc.

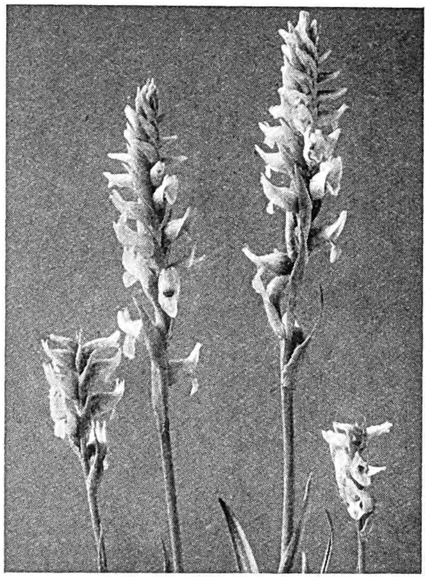
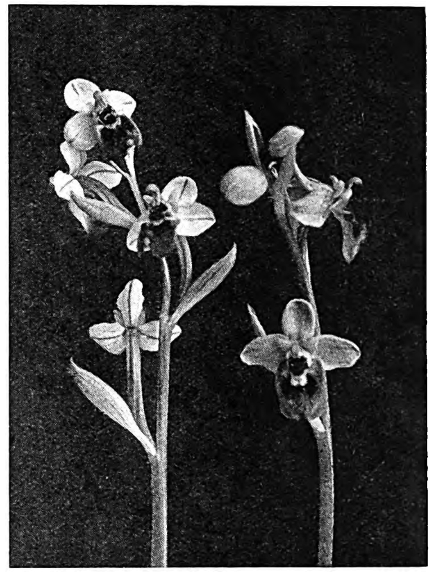
Department of Zoology, University College, London.

The wild orchids of Europe present a field for exploration which offers opportunities to the holiday-maker on the continent. There is much scope for the experimental hybridization of these curious plants.

TROPICAL orchids of the more showy kinds are familiar objects to many, with their curious and reptilian as well as elaborate and beautiful forms. Their culture, moreover, is a well-studied art, and a considerable amount of experimentally-gained knowledge exists of their potentialities and behaviour when hybridized with one another. The wild orchids of Europe, on the other hand, present a field which has been less fully explored, at least on the cultural and experimental side; nor are these plants well known to the public as are their tropical counterparts. The number of species of orchids which occur wild in Europe is, however, considerable, and although their flowers are usually built upon a smaller scale than those of the ordinary hot-house species, they exhibit a variety of curious form which parallels that of the larger and more imposing species. There exist, of course, many tropical species with small flowers; but since these are less often exhibited in public places than the showy varieties, their existence is not obvious to the uninitiated.

A few of the more interesting European orchids are illustrated in this article. Of these none is more beautiful than the species illustrated in Fig. 1, the rare *Calypso borealis*, in which each flowering stem bears a single pink flower with markings in other colours upon the hollow slipper-like lower petal (the *lip*). Another beautiful but extremely rare species is that shown in Fig. 2, *Spiranthes stricta*, more usually known as *S. Romanzoffiana*. This plant has small cream-coloured flowers, but they are borne in a graceful spiral formation upon the stalk. It is interesting particularly because of its distribution, being a plant which occurs in Ireland alone on the European side of the Atlantic, but which is not uncommon in North America.

It is a marked characteristic of the European orchids that many of them hybridize more or less freely in the wild, and that the hybridization is by no means limited to an interchange between related species; hybrids between species belonging to different genera

FIGS. 1-3.

INTERESTING TYPES OF EUROPEAN ORCHID.

1(left). *Calypso borealis*, one of the most interesting of European orchids. 2 (centre). *Spiranthes Romanzoffiana*, the Irish 'Ladies Tresses." 3 (right). *Ophrys tenthredinifera*, one of the insect-like species.

are of frequent occurrence, and there are also on record cases which are probably due to secondary crosses between a hybrid and one of its parents or between a hybrid and another species. Some of the hybrids produced are plants of unusual appearance, and the manner in which the various characteristics of the diverse parents are combined in them also makes an interesting study. Most of our knowledge of these hybrids, however, has been gained by field work and descriptive analysis, and there is much room for experimental hybridization and for the following of the development of the hybrids through several generations. It has been claimed that among these orchids, as elsewhere, a new species may arise from the stabilization of a stock of hybrid origin, and an experimental proof of this would be a valuable contribution to the study of evolution. The difficulties in the way are, among others, that these terrestrial orchids cannot, any more than the kinds more usually cultivated, be successfully reared without an adequate nursery and much expenditure of time, and that a young plant produced from seed does not flower for a number of years—sometimes as many as sixteen—after germination.

The occurrence and peculiarities of hybrids may now be further considered. Wherever two species of orchid grow together, hybrids may occur (unless the species concerned should be such as to render hybridization impossible), but it does not follow that they will do so: in one locality hybrids between two given species will be more or less frequent, in another spot the same two species may grow together but no hybrids will be found. All species do not, moreover, hybridize with equal readiness. The hybrids produced are generally of the kind which present an appearance intermediate between that of the two parents, but sometimes (and especially in complex hybrids) the characteristics of one parent predominate; new features not apparent in either parent may also appear. In hybrids between the genera *Orchis* and *Serapias*, the flowers have no spur on the lip; in this case the spur is present in *Orchis* and absent in *Serapias*, and has been suppressed in the hybrids. In crosses between *Orchis* and the spurless genus *Aceras*, on the other hand, the spur is present, but is shorter than in *Orchis*. In some cases there is considerable variation between different examples of the same hybrid. A more detailed account of the hybrids of European orchids, which also takes into account the experimentally produced exotic hybrids, will be found in an interesting paper by Col. M. J. Godfery, entitled "Natural Orchid Hybrids," in *Genetica*, IX, 1927, p. 19. This paper is well illustrated.

Among the interesting facts which the artificial crossing of orchids has elicited are the following (quoted from the article by Godfery above mentioned). In some crosses the influence of the male or female parent is so strong that the other is swamped almost or quite completely. If *Sophronitis grandiflora* be crossed with *Epidendrum radicans*, the hybrid (which can only be obtained with the *Epidendrum* as male parent) is almost exactly like a dwarf *Epidendrum*.

An even more striking case is that in which *Zygopetalum Mackayi* was used as female parent in a cross with pollen from *Odontoglossum*, *Lycaste*, etc. The hybrids appeared to be pure *Zygopetalum*, and four hundred seedlings raised exactly resembled the mother plant. A plant of the fourth generation of *Zygopetalum*, fertilized in each case with *Odontoglossum crispum*, still reproduced the *Zygopetalum* unchanged.

A number of European orchids (belonging to the genus *Ophrys*) have the lip so modified that it resembles some insect very strongly, the other petals also lending themselves to the general effect. The sepals, on the other hand, remain petal-like, and are often brightly coloured, so that the total effect is that of an insect which has alighted upon a flower. The lip possesses smooth areas and hairy or velvety ones, and is so shaped and coloured that it may resemble either a bee, a fly, or a spider. That it is really intended to resemble an insect is evident from some of the details of its structure—it may possess spots resembling eyes, situated in the right place, and in one of the examples shown in the accompanying illustrations (Fig. 5), the lip possesses lobes which resemble folded wings (held out at an angle from the body) as well as hummocks at the bases of the latter which suggest the elbows of flexed furry legs. In other cases a bluish shiny area on the middle of the lip gives the illusion of the bluish sheen on the folded wings of a fly. There are too many resemblances involved for explanation on the ground of accident. The matter is clinched by recent observations, which show that in certain of these species the lip is mistaken by certain male insects for a female of the same kind; the male alights upon the supposed female and attempts to fertilize her; carrying away the pollen of the orchid incidentally, and with it effecting the fertilization of another orchid-flower. This adaptation is one of the most interesting instances of the type to be found; and it is one which calls for careful attention from those who would explain the phenomena of evolution by natural selection and by this alone.

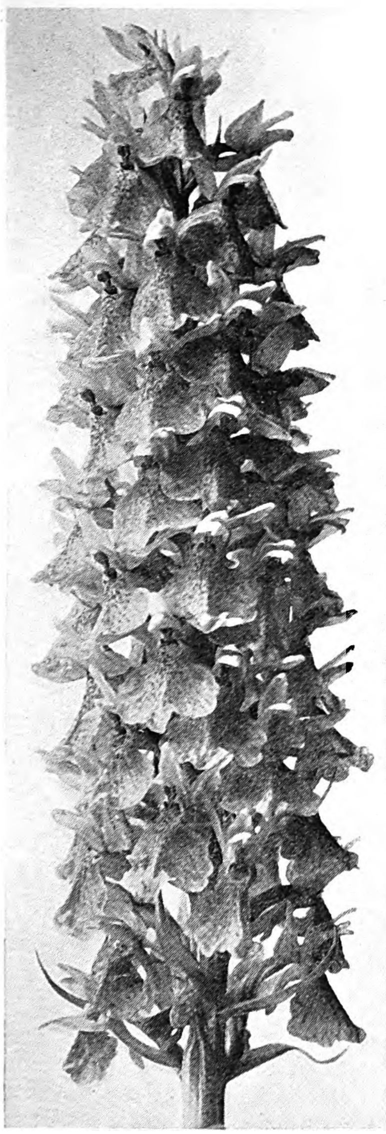
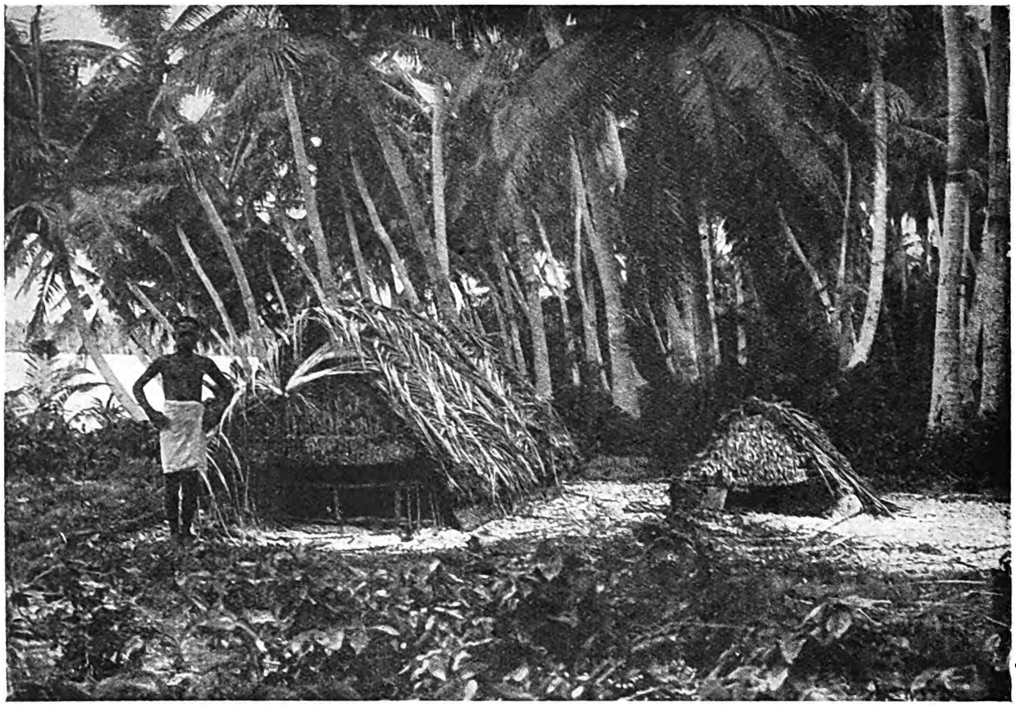


FIG. 4.
TYPICAL MARSH ORCHID.
(*Orchis Munbyana*.)

FIG. 5.
ANOTHER INSECT-LIKE ORCHID.
(*Ophrys Cornuta*.)

Many of the European orchids are relatively constant in type, the species being well marked and easily recognizable. This does not apply universally however, and the contrary condition is best exemplified among those species of the genus *Orchis* which possess palmately-divided root-tubers (the *Dactylorchids*). These are the marsh orchids and spotted orchids so common in Great Britain and in Europe generally. Among these forms the species are sometimes rather similar to one another, and in certain localities several of them occur together and hybridize so freely that a casual collector entering a field populated by one of these colonies might well be excused for mistaking the species and hybrids involved for a single kind of orchid exhibiting a wide range of variation. A considerable amount of work has recently been done on these difficult species, from which it has emerged that there are indeed a number of different kinds involved, with hybrids linking them up. The distribution of these forms is interesting. In North Africa there is found, to begin with, the showy purple species illustrated in Fig. 4 (*Orchis Munbyana*), a plant which may attain a height of three feet or more.



HOUSES OVER GRAVES IN NANOMEA, ELLICE ISLANDS.
(See descriptive paragraph on page 165. Photograph by courtesy of *Man*.)

In Spain, Corsica, and the southern part of France, this form is replaced by multitudes of a similar tall plant, with sword-like leaves and long purple spikes (*O. sesquepedalis*); this form is also found with *O. Munbyana* in North Africa. In the northern part of France, however, there appears a third species (*O. praetermissa*) which is rather like a shorter and more compact edition of *O. sesquepedalis*. This form extends into the Netherlands and all over the southern parts of the British Isles, but as one goes north and west in the latter area there become more and more frequent two forms (*O. purpurella* and *O. pulchella*) which resemble it but possess flowers of a rich deep purple unknown in the other kinds; one of these is distinctly a dwarf plant, and both of them are characteristic of the north and west of Scotland and of northern England. Other marsh or spotted orchids do not belong to the series just described, but range over the whole area involved, from the Shetlands to Spain or further; and in the eastern part of Europe other factors become involved. A detailed study of the marsh orchids, on modern lines, taking into consideration not only their morphology and cytology, but also their ecology, is being made by Dr. H. Ziegenspeck of the University of Kõnigsberg; some of the results of this work, done in collaboration with the late Prof. A. Fuchs, have already been published in the "Botanisches Archiv" (II-XX), edited by Dr. Carl Mez of Kõnigsberg, and in "Naturwiss. Vereins für Schwaben." Augsburg, 1919 and 1924.

It has been mentioned above that the hybrid *Sophronitis grandiflora X Epidendrum radicans* can only be obtained by using the *Sophronitis* as the female parent. Some of the reasons for results of this kind are as follows: The *Sophronitis* only develops short pollen-tubes; and the ripe seed-capsule of a *Cattleya* fertilized by its pollen produced mature seeds at the top only, the rest of the capsule being full of chaff. Similarly, *Cochlioda Noetzliana* is a good plant to use as female parent, but its pollen usually fails to fertilize *Odontoglossum*, whose pollen-tubes have a much longer distance to traverse. Again, in some cases the pollen-tubes of one species may be too large to enter the micropyle in the ovules of another. In yet other instances, the time which is required for the ovules of one parent to become ready for fertilization does not fit in with the time required for the pollen-tubes of the other parent to reach the ovules; the times involved varying from seven–ten days to as much as three months. If plants are crossed whose germ-cells require very different periods for these processes, the development of the ovules may be fatally checked by the failure of the pollen-tubes to reach them in time; as conversely the pollen-tubes may have lost their fertilizing power before the ovules are sufficiently mature to receive their contents. These facts are mentioned here, because although derived from the study of cultivated species, they are no doubt applicable to some of the wild forms also.

For the photographs which illustrate this article I am very much indebted to Mr. W. H. St. Quintin (Figs. 1, 2 and 4), Dr. F. Pfeifler Wellheim (Fig. 5), and Dr. T. Stephenson (Fig. 3). Dr. Pfeiffer-Wellheim, of Vienna (Wien IV, Mommsengasse 21), has produced a series of beautiful stereoscopic photographs of European orchids, copies of which may be purchased from him.

Benn's Sixpenny Library: First Scientific Titles.

A Review by V. E. Pullin.

In place of noticing singly the volumes in the Sixpenny Library—a series now approaching its first anniversary, in which six new titles are published monthly—we shall review batches from time to time. This first review is by one of the authors, whose signature appears at the request of the Editor of DISCOVERY.

IN these days of intense specialization there is a very acute danger that education may be lost. It is an alarming thought, because if it comes to pass we shall find ourselves bankrupt of vision and isolated in the narrow paths of a labyrinth shut out from all beauty and even usefulness. The splendid Newtonian vision will no longer be the reward of the student of science who tends to become shut in by the narrow avenue of his speciality.

Messrs. Benn, like wise physicians, have apprehended the symptoms of this insidious disease and have prescribed exactly the right medicine; they have made it up, moreover, in the most palatable form. These little sixpenny books cover an incredibly wide field—science, philosophy, literature—indeed, the whole gamut of modern intellectual activity is comprehended in this little orange coloured library. Any attempt to review the series or any section of it must pay tribute to the Editor, Dr. William Rose, who so far has performed his arduous task in the most sympathetic and successful manner. Surely it has been no easy matter to persuade the eminent authorities whose names appear on these books to spare the time to write such careful accounts of their subjects. The achievement is most noteworthy.

Fact and Fancy.

Science has suffered in the past from a certain type of literature which is described as "popular science." Many such books may be popular, that is a matter upon which the respective publishers could speak; but often the science is entirely fanciful and partakes more of the character of, we were going to say, fiction, but perhaps musical comedy would be more apt in that there is not even a plot.

The scientific books in the Sixpenny Library, which form the subject of this article, are above all authentic expositions, and herein lies their value. The general reader may indulge his thirst for information in the perfect confidence that the knowledge he acquires, although of necessity sketchy, is nevertheless accurate. One of the striking impressions one gets after reading a number of these books is the enormous amount of information which the authors have managed to squeeze into their allotted eighty pages. In one or two instances it is positively amazing. It is striking testimony to the care which has been exercised in compiling the various accounts that in no case, in the scientific section of the library, is the book a mere catalogue of facts. Taken as a whole they are written in an interesting manner, while some indeed are almost masterpieces of literature.

One particular feature of the series which reflects credit on the Editor is the bibliography which is appended to each book. This is often divided into sections—elementary, more advanced, advanced, and so on—so that the reader may find the road into the very heart of the subject without difficulty. He should be warned, however, that he will not find many of the textbooks to which he is referred quite so appetizing as the carefully prepared sixpenny bait.

Why and Wherefore.

The man in the street nowadays lives almost entirely in an atmosphere of science, so that he is abnormal indeed if he does not seek to know something of the marvellous forces which he, consciously or unconsciously, invokes in every moment of his life. Sometimes when some striking phenomenon is made particularly conspicuous, as in the case of broadcasting, it constitutes a stimulus to delve into the outer mysteries of science, and thousands of people become active manipulators of valves and condensers because they can easily acquire sufficient proficiency to produce tangible results. Education, however, demands more than this somewhat superficial interest. It is the *why and wherefore* that constitutes the real interest and romance of science. How many people who buy and familiarly discuss the merits of wireless valves know anything of the stupendous little planets called electrons whose discovery made wireless valves possible?

The philosopher of Newton's time was thrilled by the realization of the order governing the movements of the heavenly bodies. In our time we have become aware of the extension of scientific order into planetary systems, millions of times smaller than the tiniest speck of dust that we can imagine. We have learned with an uncanny exactness all about the structure of that wonderful system, consisting of chiefly empty

space, which we call the atom. Still more wonderful is the knowledge that everything that we experience is made of discontinuous units. All matter is granular, and now it seems that not only matter, but light and electricity, far from being continuous wave phenomena are granular in structure also. Only a very few years ago it would have been a bold man who dared to say what electricity was. There is a story told of Lord Kelvin, who, when Professor Thomson, was lecturing to a class of students ; one of whom had fallen asleep. Thomson woke him up with the question, " What is electricity ? " The dazed student replied, " I am very sorry, Professor, I *did* know but for the moment I have forgotten." This story never failed to excite laughter —the one man in the world who knew what electricity was had unfortunately forgotten. If the same question were asked of any second year science student to-day he would have no hesitation in giving the correct answer at once.

Progressive Discoveries.

The romance of the progressive discoveries in physics constitutes a fascinating story that cannot fail to hold the most luke-warm inquirer. The Sixpenny Library tells the whole story. No longer is the introduction to science made laborious by a series of menacing symbols and equations which have no meaning until, by laborious spadework, the student has mastered the subject. That system has been replaced by the better one of first describing the wonder and beauty of a phenomenon. Then, having thoroughly whetted the student's appetite, it will be safe to leave it to his own interest to acquire knowledge of the more difficult and detailed aspects of the subject.

The Sixpenny Library lends itself very readily to systematized courses of reading, and in the scientific branch at all events a most thorough acquaintance may be formed with modern thought by arranging the titles in some simple order.

In the course of the following remarks on the first books* we shall consider them in the order that is suggested as being suitable to assist the reader to grasp current views on general scientific matters, and also at the same time to maintain a proper sequence of thought and interest.

Perhaps the first book to read should be *Sir Isaac Newton*, as it is a comprehensive sketch of the life and main scientific discoveries of the greatest scientist who has ever lived. He was born nearly three hundred years ago at a time when science was just emerging from the darkness of superstition. Newton's discoveries still form the very basis of modern scientific thought, and the story of the unfolding of nature's pages by this true superman will be found a useful foundation upon which to build our little course of instruction. Very naturally man's earliest interest in scientific or natural phenomena was concerned with the observation of the heavens, and it was in this field that Newton attained his most sublime triumph—the discovery of the Law of Gravity. Obviously then the next books on our list are those two charming essays by Professor George Forbes, *The Earth, the Sun and the Moon* and *The Stars*. There is no doubt that Professor Forbes teaches us how to acquire an astonishing amount of astronomical knowledge in the form of an exceedingly good game. Phenomenal distances are made intelligible. Such interesting things as the horizon, the mass of the earth, methods of measuring the distances of stars from us, the nature of the spots on the sun, the value of the spectroscope in telling us what elements exist on other planets, and a host of other fascinating matter is dealt with in a delightfully familiar way. In the book on the stars we are shown how we may identify any particular star with such homely apparatus as an open umbrella and a walking stick, and there are enough simple experiments described in the book to afford a season's entertainment far more thrilling and infinitely cheaper than anything that picture palaces or theatres could offer. A cursory acquaintance with the nature of the sun, earth and stars prompts us to search for more detailed information, and in Professor Arthur Holmes' book, *The Age of the Earth*, we shall find it. The earth is about 5,000 million years old. It is perhaps difficult to form any mental picture of such a stupendous time, but Professor Holmes arranges his evidence, and describes various natural time-keepers to such excellent purpose, that such matters as radio-activity and geological systems become almost as simple as clockwork and digging for worms.

The Infinitely Small.

In the last three books we have been considering vast systems involving the consideration of figures running into millions of millions. In recent years, however, science has rather tended to consider the infinitely small. We shall now have to train our minds to think of entities many millions of times smaller than anything we can see. Before doing so, however, it may be well to consider the general principles, as it were, upon which the scientist works. What are the laws which are always applied to any study of scientific phenomena ? Let us next take

* Published by Ernest Benn, Ltd., 6*d*. each volume.

Dr. W. A. Caspari's book *The Structure and Properties of Matter*. Here we shall learn about the general laws of physics and chemistry without realizing that we are covering such a large field. Why is a lubricant a lubricant? Why is -273° centigrade the absolute zero of temperature? What is the difference between a body that is crystalline and one that is not? There are dozens of fundamental questions like this that we must understand if we are to gain any intelligent knowledge of modern science. Dr. Caspari answers them all with a clearness that denotes, not by any means the simplicity of the subject, but rather the carefulness and the skill of the master. The amount of information in this particular book is remarkable.

Modern Physics.

We will now proceed to Sir Oliver Lodge's *Modern Scientific Ideas*. To acclaim Sir Oliver Lodge as an expounder of modern science would be to gild the lily. In this book he tells us all about the discontinuous nature of matter, light and electricity,. and the book forms an excellent preamble to the next one on our list, *The Atom*, which is the work of Professor E. N. da C. Andrade. This book in many ways is the most remarkable of the series. Professor Andrade has some advantage, perhaps, in that he writes on one of the most fascinating subjects of modern times, but this fact must not be allowed to take anything from the credit that is due to the essay. In the course of our study of the structure of the atom we have to learn about the nature of light and radiation in general. Professor Andrade explains how the atom broadcasts, as it were, the various forms of radiation with which we are familiar under the name of light, X-rays, wireless waves, and so on. He also tells us how the ability of atoms to combine and form chemical molecules is accounted for on the modern atomic theory. The facile pen of the author has endowed atoms and electrons with a strange familiarity and the reader cannot help feeling that here perhaps is the ground where applied science and speculative philosophy may one day meet.

In Professor Spielmann's *Chemistry* the importance of the subject is emphasized by the author, and we learn in what a variety of ways the science of chemistry is of importance to industrial activity.

This particular section of our scientific course of instruction cannot be closed to better purpose than by reading Professor James Rice on *Relativity*. This book deserves high praise. It is an attempt to perform a miracle, and it must be admitted that the attempt is, as far as it is humanly possible, successful. It is an excellent dissertation on Newtonian principles. The conception of relativity is dealt with in a most ingenious manner and without recourse to any mathematical symbols. There is no doubt that the reader obtains a clear idea as to the impossibility of absolute time and space. The emergence in his mind of a mental image of something to take its place is also unquestionable, but what that something is cannot be made clear without abstruse mathematical analysis. Professor Rice is experienced in the interpretation of this profound conception and, as we have said, comes as near to perfection as it is possible to do.

One excellent feature of this book makes it perfectly clear that Einstein has built his wonderful superstructure upon a Newtonian basis. There is a widespread belief that Einstein arose as an enemy and destroyer of all that Newton ever achieved. There is, of course, no greater error, and in *Relativity* the true perspective of the doctrine of relativity is set forth with admirable clearness. Particularly ingenious is Professor Rice's explanation of space-time. It is remarkable how he has succeeded in conveying a very real idea of this somewhat difficult concept without the use of a single mathematical symbol. The reader who carefully studies this book will certainly acquire a very cogent idea of the meaning of that singularly formidable word, relativity.

(*To be continued.*)

Houses in Graveyards.

A new ethnographical observation from Oceania is published in the April issue of *Man* by Mr. Patrick Buxton, who describes the erection of houses over graves in Nanomea, Ellice Islands. The body is buried in the ground, the area over the grave is strewn with white coral, and on this a house is erected. The larger house in the photograph which we reproduce on page 162 was the biggest seen, and was about five feet high to the ridge and six feet long. The native pastor explained that in old days burials had taken place in the houses of the village; but now that it has become the rule to bury in the cemetery, the people still erect a little house over the grave.

It is interesting to observe this blending of heathen and Christian customs in so intensely devout a place as the Ellice group. It appears that nothing quite like this is on record from any part of Polynesia, though Mariner describes the erection of huts in the burying ground of a chiefly family, and the strewing of the grave with white and black pebbles.

Book Reviews.

The Biology of Insects. By GEORGE H. CARPENTER, D.Sc. (Sidgwick & Jackson. 16*s*.).

This volume is one of a series of which, apparently, four others have appeared previously, and each deals with the biological aspect of some group of animals or plants. The book is really a number of essays in which the author has put together a large amount of material—and there is plenty of evidence of extensive reading—in a very pleasant manner. As a rule, the author has contented himself by telling his story without expressing definite opinions, but occasionally he comes out strong. For instance, he has a poor opinion of the theory of " race memory," and will not even allow that a student of insect behaviour would seriously suggest that an adult insect, in choosing its place for oviposition, could possibly do so by remembering its own larval life (pp. 102-107), a point upon which there is, at least, another opinion !

The author distinguishes between Family Life (Chap. VIII) and Social Life (Chap. IX), which is distinctly an improvement on Wheeler (" Social Life among the Insects "), but he then confuses the two, even after defining what he regards as the distinction. He says, " In some cases the members of a family remain in association for a shorter or a longer period of larval life ; when the association is preserved after the adult condition has been attained, the family may be said to pass into a community, and the life of such insects becomes definitely social " (p. 200). This definition is obviously incomplete, as it would include a swarm of locusts, which are certainly not social, and would exclude a similar association, a swarm of caterpillars (*e.g.*, " army-worms "), merely because the latter are not adult.

In the chapter on family life there are several pages upon secondary sexual characters and courtship, although family life usually begins after the courtship is over. In the early pages of Chapter VIII the habits of the Scolytid Beetles, known as " Ambrosia " Beetles, are dealt with as social, although the association of adults is only a family affair in so far as a male is polygamous, and is in no way comparable with the social life of Termites, Ants, etc. The real association is between mother and offspring, which should come under family life. In the last chapter, entitled " Insects and Man," the author sets out a few of the cases in which insects affect the human race, and only in a very few words does he refer to the question, recently raised by several authors, especially Forel, as to how far the insect societies are models of the human society. I would recommend the book as a sequel to the author's earlier volume entitled " Insect Transformation " for those who are seriously pursuing the study of entomology, but it is full of interest for those who are otherwise interested in the subject.

FRANK BALFOUR BROWNE.

Man Rises to Parnassus. By HENRY FAIRFIELD OSBORN. (Oxford University Press. 11*s*. 6*d*.).

In the introduction to " Babbitt," the non-American reader is warned that he may find Mr. Sinclair Lewis' style rather difficult. The same may also be said of that of Professor Osborn. Indeed, the book is composed in a style which will be strange and rather annoying to the average English reader, and by no stretch of imagination can the book be described as well-written. The use of the adjectives " geologic " and " archaeologic " appears strange and rather unpleasant to the Englishman, and yet, were the familiar " l " added to them, the style is far from satisfactory, and the book appears to be a series of comprehensive extracts from a number of authors, rather than a digested account from the author's mind.

There seems to be nothing new under the sun, for Professor Osborn shows us that the Greeks had definite ideas about the evolution of man, and quotes extensively from Aeschylus. The theme of the rest of the book is simply told. Briefly, it is an illustration of the author's particular views on the subject of human evolution. His ideas are too well known to need much mention here, but he derives modern man from a race of Tertiary " Dawn Men," who were not arboreal in their habits, and he inclines to the view that apes and men have come from entirely different stocks. Still, in his research into the Tertiary for relics of these Dawn Men, the author is content to stop at the Pliocene, and makes no mention of the flints of Puy Courny and Puy Boudieu of the Upper Miocene.

After a brief account of some selected Palaeolithic stations, we are introduced to the work of Oscar Montelius, who has applied the chronology of de Geer to the study of the dates of post-Palaeolithic cultures, and with this as groundwork, we review the " Mesolithic " and later periods. The illustrations to the book are exceptionally numerous and good, but it is certainly very strange to hear that the author made an excursion with " Professor J. E. Marr, the geologist of Oxford University " !

J. E. HALLIDAY.

The Elements of Economic Geology. By J. W. GREGORY, D.Sc., F.R.S. (Methuen. 10*s*.).

To the man in the street geology presents peculiar difficulties. Although desirous of learning the elements of the science, he seems to be up against a stone wall, and can find nothing tangible or perhaps even of interest to which he can firmly fix himself. Even enthusiastic geologists will admit that this is true, and the unbroken rows of specimens in our museums help but little to dispel this conviction. A perusal of this book will greatly help the understanding public to see and appreciate the economic aspect of geology, and will go far in helping to break down initial trouble and to lessen the fatigue caused by the " five finger exercises " of the science.

In *Discovery* for March we had the pleasure of reviewing the first book of this series, appearing under the general editorship of Professor J. W. Gregory. The general editor has now also assumed the role of author, and as we expected the high standard of the earlier work has been fully maintained in the present one. Incidentally the quality of the paper has been much improved.

To the more advanced pure or economic geologist it provides a wealth of information in the form of reliable text and numerous references, both from British and foreign sources. The increasing practice of dividing the index into a number of indices, comprising author, localities, and subject is, however, very annoying. The whole only comprises a total of fifteen pages, and we can see no valid reason for the division, except perhaps as a lesson in patience for those who have in the course of their daily work to consult some scores of indices. This agony was spared the reader in the first book, and we hopefully look forward to its elimination in the third and last of this excellent series—a book on general stratigraphy by Professor Gregory and Mr. B. H. Barrett, which we understand is now in course of preparation.

F. S. W.

Hermes : or the Future of Chemistry. By T. W. Jones. (Kegan Paul. 2*s*. 6*d*.).

This new volume in the well-known "To-day and To-morrow" series deals with the future of chemistry. Among the points dealt with by the author, as likely to be of great importance in the future, are the production of synthetic petrol; changes in constructional materials, in the direction of new light alloys and new cement products; the production of entirely new artificial fibres from cellulose (the author being of the opinion that in producing imitations of silk and wool we have not exploited the greatest possibilities); nitro-cellulose lacquers; foods and the growth of crops; and the development of a new chemo-therapy, in which it will be the aim of chemistry to enable the organism of its own accord to set its parts in order. Special emphasis is laid, in this last respect, on the remarkable results which may be expected to attend the increase of knowledge of hormones and vitamins.

Mr. Jones does not subscribe to the view that the food of the future will be a synthetic tabloid product, but is of the opinion that the direction of advance will be in the production of crops (wheat, etc.), containing various essential dietary constituents (carbohydrate, fat, protein, etc.) in the correct proportions. The production of meat will dwindle. On the chemo-therapeutic side, "the chemical control of sex cannot be regarded as remote, even though there appears to be no indication of its introduction in the immediate future. . . . The development in the child of a full complement of hormones will be an increasingly attended care of the future."

B. F.

The Fundamentals of Astronomy. By S. A. Mitchell, Ph.D., LL.D., and C. G. Abbot, M.S., D.Sc. (Chapman & Hall. 15*s*.).

This is a semi-popular treatise on astronomy, written by two well-known American astronomers. Some of the text and many of the illustrations have appeared in Dr. Abbot's previous book, "The Earth and the Stars," but this is quite by the way. The first chapter is entitled, "How to Know the Stars," and is in the nature of a flight of fancy, intended to stimulate the beginner to take an interest in the starry heavens. In Chapter II is given an interesting account of the most famous astronomers of the past and their labours. Delightful little biographical sketches are supplemented by a short, though interesting, account of the foundation and equipment of the Lick Observatory, and Mount Wilson Observatory. The next two chapters are devoted to the earth, its size, mass, internal condition, motions, etc. Chapter V contains a discussion on time, in its relation to astronomy. A good part of the chapter is concerned with the calendar and its history, and forms very interesting reading. The chapter closes with a brief sketch of the use of astronomy in navigation. Chapter VI deals with the moon and the tides. The photograph which is reproduced as Plate 13 is printed upside down, which was also the case with the same photograph in "The Earth and the Stars." Perhaps the publishers will note this and rectify it in the next edition. This slight error, however, does not detract from its value as an illustration. Chapter VII is a summary of what is known about the planets, and as it only occupies twenty-two pages, the treatment is necessarily somewhat sketchy. Chapter VIII is on "Comets and Meteors," in which there occurs, in addition to astronomical matters, a good story about Messier, the French discoverer of comets. The next two chapters deal with the sun and eclipse phenomena, and form a very readable account of solar physics. Chapter XI is one of the most interesting in the whole book, as in it the authors describe various ways of obtaining power on an industrial scale from the sun's rays. Needless to say, in our climate, very little can be done in that way, but in tropical countries sun-power engines have been tried with conspicuous success. The remainder of the book is devoted to stellar astronomy and astro-physical matters, the presentation being clear, accurate, and up to date. Perhaps the most thought-provoking chapter in the book is the final one, entitled "Building the Universe." The quality of the paper and the illustrations are excellent, though we are forced to the conclusion that the price seems a trifle high. However that may be, the book should appeal to a wide circle of readers who do not wish to struggle through a mass of technical stuff, but, on the other hand, want to know something about astronomy. A very readable book indeed.

J. A. Lloyd.

Ultra-Violet Rays in the Treatment and Cure of Disease. By Percy Hall, M.R.C.S., L.R.C.P. (William Heinemann (Medical Books) Ltd. 12*s*. 6*d*.).

A Textbook of Actinotherapy. By D. D. Rosewarne, M.R.C.S., L.R.C.P. (Henry Kimpton. 9*s*.).

Physics in Medical Radiology. By Sidney Russ, D.Sc., L. H. Clark, Ph.D., and B. D. H. Watters, M.Sc. (Chapman & Hall Ltd. 12*s*. 6*d*.).

As the preface to one of these books points out, there is no need to emphasize the important part that radiology plays in medicine, whether in radio-diagnosis or in radio-therapy. The universities of Cambridge, Liverpool, and Edinburgh now grant a diploma in medical radiology, and their example is being followed by others no less anxious for the status of their speciality.

Professor Leonard Hill contributes an introduction to Dr. Percy Hall's book, in which he remarks that we cut off the natural effect of sunlight on the skin by clothes, glass, brick walls, and smoke pollution, while in winter the light in this climate is in any case very small. In a short time he predicts that arc light baths will be therefore widely used, and will have a great beneficial effect on city people in particular. As its title suggests, however, the book deals with specific diseases rather than with general conditions of health, which as everyone may benefit by sunlight and its substitutes are scarcely less important.

Perhaps Mr. Rosewarne's is the most comprehensive of these books. After dealing with the constitution of matter and physical phenomena, he proceeds to describe the types of instrument and the action of light on the body. In this last connexion he deals with the skin, the blood, and the effects of light on metabolism. A section of the book is devoted to clinical procedure, in which the forms of administration of light treatment are discussed with photographic illustrations. A chapter on limitations and dangers is wisely included, as considerable damage may result from the haphazard use of this new cure.

The third volume under review is written jointly by the professor of physics at the medical school of the Middlesex Hospital and two research assistants. This is a sufficient commendation for a work which everyone concerned with the subject should read; it cannot be urged too strongly that a knowledge of the principles involved is of the utmost importance in ultra-violet treatment.

Animal Biology. By J. B. S. HALDANE and JULIAN HUXLEY. (Oxford University Press. 10s.).

The authors names are a sufficient commendation for this book, which is designed as an introduction to the general principles of the subject. They point out that recent brilliant work in pure physiology is now becoming linked up with general zoology, and we are in a fair way towards the possession of a real science of developmental physiology, linked up at one end with pure physiology and at the other with heredity. Evolutionary studies, after falling on somewhat evil days as the result of too much theorizing and arm-chair speculating, are feeling the stimulus of this new knowledge. In brief, biology is at last beginning to be a unitary science, in which discoveries in one branch rapidly come to alter our outlook in other branches.

The book has been written with these circumstances in mind, and unlike many of the available textbooks a detailed treatment of the subject is thus linked together by a continuous theme. The work is profusely illustrated, and while written simply is decidedly more solid than much of the "popular" scientific literature now being produced.

Rossel Island: An Ethnological Study. By W. E. ARMSTRONG, M.A. (Cambridge University Press. 18s.).

Rossel Island, the most easterly of the Louisiade group, Papua, occupies a position of peculiar isolation. Mr. Armstrong was for some months assistant anthropologist to the Papuan Government, and he also obtained grants from various learned societies to visit New Guinea and carry out ethnological studies among its peoples. This book was primarily intended as a general survey of the culture of the island; but the discovery of an unusual system of currency led the author to concentrate on an attempt to elucidate what turned out to be a very complex monetary system. He modestly complains that other aspects of the study have been rather summarily treated, but there are fully illustrated chapters on ghosts, religion, sacred places, and sorcery. The native games and songs are also described.

Aerial Photography. By CLARENCE WINCHESTER and F. L. WILLS, F.R.P.S. (Chapman & Hall Ltd. 25s.).

The admirable illustrations and production of this volume are in every way worthy of a pictorial science which has come to the fore in recent years. Not the least interesting literary feature is a foreword by Sir Alan Cobham, from which many will learn for the first time that this famous airman was himself connected with aerial photography in its pioneer days. He points out that although air survey developed rapidly during the war, there is still much room for improvement. There are two main branches of the subject, air survey and aerial photography: progress in the former was reviewed by Major Hemming in *Discovery* some months ago, while aerial photography is going ahead rapidly, finding new uses in commerce, especially for publicity purposes.

The "Wellcome" Photographic Exposure Calculator, Handbook and Diary, 1928. (Burroughs Wellcome & Co. 1s. 6d.).

We have received for review a copy of this popular annual, on which no effort has been spared to make the 1928 issue up to date and helpful. The scope and character of the book is reflected in its contents. The frontispiece shows a reproduction of an Alsatian wolfhound produced by a novel two-colour toning method which is described in a separate pamphlet just issued, entitled "Photographic Toners and Stains." Facing the title page of the handbook is an official photograph of the Duke and Duchess of York during their tour to New Zealand and Australia. The literary contents are written as simply as possible, and include articles on development by all methods, desensitizing, intensifying, reducing, printing, toning, etc. In the exposure section the plates, films, and papers have been carefully tested and the speeds revised, the list being made complete by the addition of all new material brought on the market up to the time of publication. An article on exposure in cinematography will be appreciated by the ever-growing number of motion-picture workers. It should be noted that four editions are issued, for the northern Hemisphere and Tropics; the southern Hemisphere and Tropics; Australia and the Tropics; and the United States of America respectively.

Qualitative Analysis. By W. WARDLAW, D.Sc., F.I.C., and F. W. PINKARD, M.Sc., A.I.C. (Longmans, Green & Co. Ltd. 3s. 6d.).

The authors offer this book as one which combines the good points of both types of work at present available on qualitative analysis, in that it is comprehensive and at the same time small in size. Many instructors in school chemistry prepare their own analysis tables for the use of their pupils, but while valuable in bringing out general principles, it must be admitted that such notes usually overlook details of importance. Hence the elementary student who pursues the subject to an advanced stage may find himself later on confronted with "snags" which throw out completely an otherwise simple analysis. This book is therefore welcome as supplying a complete elementary summary of the subject, combining extensive notes with clear tables.

Manual of Meteorology. Vol. II: "Comparative Meteorology." By SIR NAPIER SHAW, LL.D., Sc.D., F.R.S. (Cambridge University Press. 36s.).

The first volume in the "Manual of Meteorology," reviewed at length in these columns last July, dealt with meteorology in history. The second instalment is naturally more technical, and covers the general circulation of the atmosphere, its normal seasonal changes, and its transitory changes; there are valuable charts for the months of the year giving the mean temperature of the air at sea level. A useful feature is a summary of units of measurements, which faces Chapter I and is appropriately entitled "Lest we forget."

Universities Yearbook, 1928. Published for the Universities Bureau of the British Empire. (G. Bell & Sons Ltd. 7s. 6d.).

This well-known annual needs no introduction to educationalists, but it is equally valuable to editors and journalists who require particulars of those who hold academic appointments in British universities throughout the world. From the academic angle one of the most useful chapters deals with the admission into English and Irish universities of persons educated abroad. Another section is devoted to centres of research, and gives a list of recent theses accepted for the degree of doctor in the various universities. This affords a valuable reference for those who are contemplating such courses, and are anxious to know what subjects have already been covered.

DISCOVERY

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Editorial Notes.

THE question of immortality of the soul has again been publicly discussed, following some remarks of Sir Arthur Keith at the University of Manchester. In his presidential address last summer to the British Association, on the modern position of Darwinism, he was careful to avoid metaphysical implications, but the new challenge leaves no doubt of its author's views. "Every fact known to medical men," Sir Arthur said, "compels the inference that mind, spirit, soul are the manifestations of a living brain, just as flame is the manifest spirit of a burning candle. At the moment of extinction both flame and spirit cease to have a separate existence." Sir John Bland-Sutton came to his support with the lines of a poem, which concludes:—

> Youth often laughs at death, but old men weep,
> Wise men know death to be an endless sleep.

The opposing view was at once expressed by Sir Oliver Lodge, who compared the brain to a musical instrument and the mind directing the brain to the music—"the real thing behind the scenes." As, however, we cannot measure such factors in terms of physical science, the controversy has little intrinsic value; its more serious aspect is the effect on the general public. Credit is due to Sir Arthur Keith for speaking his mind, but there is every ground for Mr. Alfred Noyes's criticism, that he has attacked on insufficient evidence one of the keystones of a great religious faith, affecting the innermost life of millions of people; and that further, coming from a Fellow of the Royal Society, such dogmatic sentences may affect the claim of science to speak with authority. We may add that they also help to justify, at the other extreme, dogmatic theological assertions for which the evidence is equally uncertain.

* * * * *

While our May number was in the press, Captain G. H. Wilkins made a successful flight of two thousand miles across the Arctic Ocean, thus following closely the Atlantic east-to-west record of a few days previously. The course taken, from Point Barrow, Alaska, to Spitsbergen, did not actually pass over the North Pole, and considerable belts of cloud interfered at times with observation. Captain Wilkins was accompanied by Mr. C. B. Eielson. No landing was attempted in the polar region, but they were forced to come down on the shore of Ice Fjord owing to difficulty in finding King's Bay, their intended destination. Four days were spent in the grounded machine, after which the airmen appear to have had considerable adventures in getting it off again, to complete the journey. During the first part of the flight they had crossed the unexplored Beaufort Sea.

* * * * *

Further news of Nova Pictoris, which recently became double, indicates that the star now appears as an elongated nebulous mass, divided into four portions. It is surrounded by three rings, the outer one three minutes in diameter. There are two possibilities about these rings. If they are of similar nature to the nebulous ring round Nova Persei in the autumn of 1901, they give a distance of several thousand light-years for Nova Pictoris. If they are due to the actual expulsion of the outer layers of the star, its distance must be very moderate, only some forty light-years. It is stated from Johannesburg that the rings are increasing in diameter a second a day, and we may hope that the next few months will enable their true nature to be determined. The star has been put down for careful observation of parallax. If it is really at the small distance, the theory of the collision of two stars must be abandoned, for there would

in that case be much greater proper motion than that of one and a quarter seconds in twenty-four years.

* * * * *

A recent article by the scientific correspondent of *The Times* dealt at length with the bird migration theories first advanced by Commander Acworth in *Discovery*. Some fair and interesting comments were made on his views, but as no reference was given to their original source, it may be well to remark on certain points arising out of the article. We do not necessarily endorse our contributor's case, but at least it should be read in full if *The Times*' criticism is to be of serious value. Remarking that "the wind may blow as it listeth" but the migratory birds keep their appointments year by year, the critic suggests that it "may be" that the appointments have been fixed with reference to more or less constant streams of air. Commander Acworth, however, made his view quite clear that migrations in general follow such wind streams, not because the bird *reasons* to take advantage of their aid, but because it can do no other than move with them, flight being a single medium operation. In consequence, the speed of a bird which attempts to fly against a contrary wind will be dependent on its force, and the main wind streams are probably too strong to permit competition. The most powerful aeroplane or airship is subject to exactly the same factors; we may recall the case of the R 33, which left England with ample fuel supplies, but had only the barest margin by the time it reached New York.

* * * * *

Two pre-Viking ships and an ancient oar have just been found in Sweden by local archaeologists. The oar, made for paddling, was buried in a deep bog in Dalecarlia, and an expert has fixed its age at approximately five thousand years. A new method called the "pollen" test was employed; this consists in examining a piece of the soil where the object has been found and where pollen abounds. Geologists have drawn up immigration maps for various plants, fixing the age of their existence in Sweden. On this occasion they found no pine pollen in the clod examined, and knowing that the pine entered Dalecarlia some time after 3,000 B.C., they accordingly dated the oar as belonging to an earlier period. This "pollen" analysis, discovered by the Swedish botanist, the late Dr. Lagerheim, is looked upon as a revolutionary method of dating such finds.

* * * * *

Glasgow will this year be the centre for the annual meeting of the British Association, to be held from 5th-12th September. Sir William Bragg will preside, and is expected in his address to deal with modern developments in physics and their relation to national problems. Of kindred interest is a paper by Sir William Ellis, on the influence of engineering on civilization. Another practical problem, to be discussed by Sir John Reith, is wireless in the service of education—a subject, incidentally, which is dealt with in Sir Henry Hadow's new report. (See our review, page 202.) Two evening lectures will, as usual, be given in the course of the week, one under the title the Mystery of Life (Professor F. G. Donnan), the other on the study of popular sayings (Professor Westermarck). The meetings will be held in the university buildings, while practical study is offered by the many industries of the Clyde area.

* * * * *

Following the installation in Washington of an acoustical device for regulating the water supply, another American city has gone one better by installing an automatic policeman! Red and green electric lights are widely used in America as traffic signs at cross roads, and hitherto the colour has been changed by human operation—in the case of Fifth Avenue in New York, for example, a chain of lights covering many cross streets is regulated from central conning towers. The Baltimore device replaces this operation by a microphone, which is fixed on a post facing the side street. Normally the lights are set so as to show green along the main thoroughfare and red down the side, but in response to the sound of a motor horn the microphone reverses the colours; after an interval of some seconds these automatically resume their normal setting. In the meantime the car has emerged safely from the side street. During the three months since the automatic policeman was installed, the microphone is reported to have worked exactly to plan. Strange to say, it seems even to have escaped the attention of mischievious children.

* * * * *

We shall shortly publish an article on experiments in the rocket propulsion of an aeroplane, which are to be undertaken in Germany. Readers will recall that a year ago we discussed some plans for a rocket ship that might cross the Atlantic in two hours, and the new experiments will be described by the same contributor, Herr Max Valier. According to advance particulars, a light aeroplane weighing only 550 lb. is to be used, driven by two batteries of rockets situated on either of the fuselage, and it will be brought to rest by gliding after the power is discharged. A racing motor-car employing similar principles has already been constructed at the Opel works in Berlin, for an attempt at a world's speed record.

The Life-Histories of Pea-Crabs.

By Marie V. Lebour, D.Sc., F.Z.S.
Naturalist at the Plymouth Marine Laboratory.

New facts have been discovered about these small crabs which live happily inside bivalve molluscs. The larval stages in their life-histories, differing widely in the two British species, are now easily recognizable.

Last October I gave an account of the larval stages of a spider crab, and further research at Plymouth has now shown us the larvae of two pea-crabs. The first zoea or first larval stage of the common pea-crab, *Pinnotheres pisum*, is one of the earliest crab larvae known, for in 1835 E. V. Thompson, one of the keenest naturalists of his time, who discovered the true nature of the crab zoea, hatched them out from the eggs carried by the crab. Previously all zoeae had been considered as separate species and not larval forms. Very little has been added to our knowledge of this particular zoea up to the present time, and the only existing figures were those given by Thompson himself.

Pea-crabs are specially interesting and have been known from very early times when the ancients sang of the " Pinna Guard " and the " Pinna Watcher," attributing fanciful relations between shell and crab, and in old Egyptian inscriptions its presence is said to represent the dependence of man on his friends. Their usual home is in a bivalve shell such as a mussel, horse-mussel, oyster, or cockle. The form to which all the classical allusions refer lives in Pinna, a large wedge-shaped mollusc living buried in sand and mud which is much commoner on the coasts of the Mediterranean than it is with us, although it does occur on our coasts. Some years ago it was found much more frequently, but its rarity now is said to be attributable to the presence of pearls inside it, so that it was eagerly collected. The pearls are, however, of little value, being devoid of the true pearly lustre.

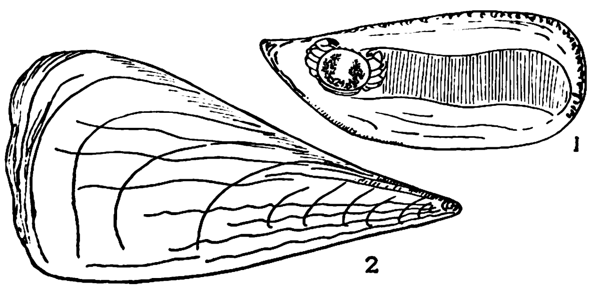


Fig. 1.

COMMON PEA-CRAB IN A MUSSEL, AND PINNA SHELL.

(1) The common pea-crab inside its host, the common mussel (4½ inches long). Half of the mussel has been removed to show the crab in its natural position. (2) Shell of pinna, 9½ inches long, in which the pinna pea-crab is found.

There are thus in Britain two species of pea-crab, one, by far the commoner of the two, is the " common pea-crab " living in the common mussel, occasionally in horse-mussels, oysters, cockles, and sea-squirts, and the " Pinna pea-crab " of the ancients living in Pinna or occasionally in other shells or in sea-squirts.

If we open a mussel, perhaps in five or ten per cent

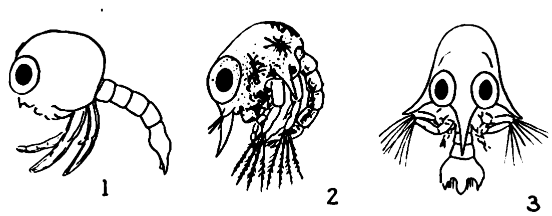


Fig. 2.

LARVAL STAGES OF THE PEA-CRAB.

(1) Pre-zoea of the common pea-crab, which almost directly becomes (2), the first zoea. (3) Is the first zoea from the front, showing its downwardly directed spines and absence of dorsal spine.

in a certain locality will be found a small round crab, perfectly at home when the shell is shut, living on microscopic food brought into the mussel by its currents and doing no harm to its " host," as the mussel is called (Fig. 1). It is the same with any of the other hosts the crab may inhabit. We have here a case of commensalism when two animals live together in a perfectly harmless association. The crab finds shelter and food, and the mussel is apparently not incommoded by its guest. Because it always lives in shelter the outside of the crab, which in free forms is hardened as an armour, is very soft and flexible, especially in the female, whose tail part tucked in under the body is very large and almost covers the eggs when she is " in berry " or bearing the eggs attached to her hind limbs. The male is smaller and not so soft, and sometimes comes outside, although he too is often to be found inside the mussels.

Whilst investigating the life-histories of various crabs at Plymouth, several " berried " females of the common pea-crab, *Pinnotheres pisum*, were taken from local mussels. Those having eggs nearly ready to hatch were placed in aquaria with a shelter of stone or shells, and the free-swimming larvae obtained. As in the spider crab, first came the pre-zoea, which

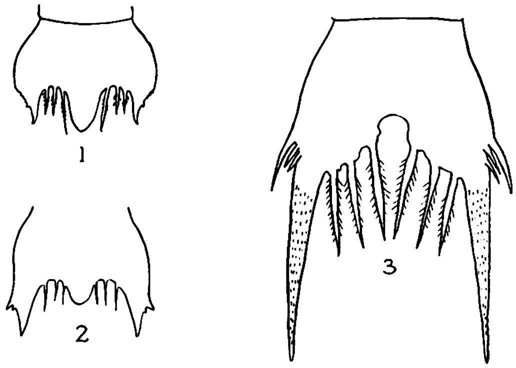


FIG. 3.
TAIL FINS OF PEA-CRABS AND SPIDER CRAB.
Telson of (1) common pea-crab, (2) pinna pea-crab, and (3) spider crab, showing the three lobes in the pea-crabs and fork in the spider crab. By the telson alone a pea-crab may be recognized.

is the first zoea, enclosed in a very delicate embryonic skin, this skin being quickly discarded and the first zoea freed (Fig. 2). A typical crab zoea has four long spines on its body which are mainly for directive purposes and for keeping in the upper water layers. In the spider crab previously described there was only one such long spine, situated dorsally in the middle of the back. The zoea of the common pea-crab has no dorsal spine, but it has one at each side bending down and one bent down in front of the eyes. Thus none of the long body spines stick out so as to present a resisting surface to the water. The reason for this appears to be that the zoea naturally does not live in the upper water layers, but keeps near the bottom. Those living in the aquarium when first hatched rose to the surface, but very soon they seemed naturally to keep near the bottom where they fed on *débris*.

The zoea is extremely small, rather less than a millimetre in length, and has a tendency to curl itself up in a ball with its tail tucked under its body, thus again enabling it to keep down in the water. Like the spider crab it has two pairs of long limbs, each armed with four bristles by means of which it swims, and these limbs eventually change to mouth parts, the true legs at this first zoea stage being mere rudimentary buds. In front are two large eyes and two pairs of feelers, the hind pair being very rudimentary, and three pairs of jaws. The front part of the body as far as the rudimentary legs is covered by a shield, the *carapace*, and behind is a jointed tail, the *abdomen*, which at the end bears a tail fin, the *telson*. The telson in these pea-crabs is peculiarly shaped and unlike that of any other larval crab in having three lobes instead of the usual fork as in the spider crabs (Fig. 3). By the telson alone a pea-crab may be recognized.

It was unfortunately not possible to rear the larvae beyond the first zoea for, although they ate microscopic plants (diatoms) and *débris* in the aquarium, they never changed to a later stage. One later stage was, however, found from plankton taken near the shore, which was probably the second zoeal stage. This was interesting, because the long spines of the carapace were greatly reduced, showing that it was still more of a bottom form. From the rudimentary limbs on the tail, which were very small, it could be seen that this was not the last zoea, and we can thus be certain that the common pea-crab has at least three if not four zoeal stages before changing into the megalopa or last larval stage.

Now the interesting fact about the larvae of the pea-crabs is that they vary very much in the different species, and although Pinna is now so rare about

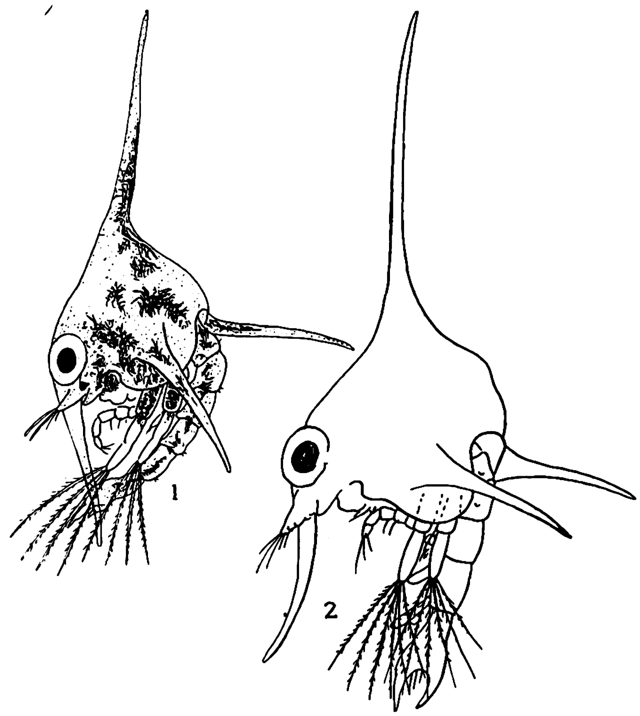


FIG. 4.
THE PINNA PEA-CRAB.
(1) First zoea. (2) Second and last zoea, showing the four long spines on the shield or carapace.

Plymouth that the adult Pinna pea-crab could not be found, yet the larvae were found in the plankton. Further, while these agreed with the common pea-crab in having a three-lobed telson and rudimentary second feelers, they were very unlike in other ways. The Pinna pea-crab, *Pinnotheres veterum*, is in the first place very much larger than the common pea-crab in its zoeae (Fig. 4)—first zoea 1.5 mm. long, second zoea 2 mm.; secondly, they had four long spines

on the carapace, one long dorsal spine, sticking up, one long spine each side bent downwards and outwards, and one long spine bent down between the eyes. The zoea was thus quite well adapted for keeping in the upper waterlayers. The colour is quite different too, brownish and pink instead of yellow and black. Another important difference is that the first zoea is much further advanced and already has rudimentary limbs on the tail. The first zoea kept in an aquarium changed to the second, and this was so far advanced that it was evident that it was the last zoea having long rudimentary tail limbs and the rudimentary legs well advanced. There are six long hairs on the swimming limbs. The second zoea from the plankton changed in the aquarium to the megalopa or last larval stage (Fig. 5). This stage is also free-swimming, but instead of being flattened from side to side like the zoea it is flattened from above downwards. Also, instead of swimming with the hind mouth parts adapted for swimming organs, as in the zoea, these have now taken on their true function as mouth parts and the true legs are fully developed, the swimming being done by the tail limbs which now are armed with long bristles. The megalopa of the Pinna pea-crab is nearly straight in front, and has a smooth carapace without spines. It measures nearly two millimetres in length and closely resembles a true crab, tucking in its tail frequently and often remaining on the bottom, although at times it can swim freely.

The Final Change.

Unfortunately it could not be induced to change further. The next change would almost certainly produce a true crab, and in all probability this would find a tiny Pinna and enter in. It is not known for certain how early a pea-crab enters its host, but small mussels are often found to contain very small crabs.

Except for Thompson's work referred to above, and a very brief note on the newly hatched Pinna pea-crab by Gourret from Marseilles, these facts relative to the pea-crab larvae are new. The chief interest lies in the different character of the two larvae showing adaptation to different habitats, and a much shorter life-history in the larger species.

FIG. 5.
THE LAST LARVAL STAGE.
(1) Megalopa or last larval stage of pinna pea-crab, from second zoea from Plymouth. (2) Adult female pinna pea-crab from Naples.

A Shakespeare Problem.

THE Master of Jesus College, Cambridge, whose interesting "Chapter in the Early Life of Shakespeare" recently attracted wide attention, has now set himself to solve another problem, "How Shakespeare 'Purged' Jonson" (Heffer. 2s.). The matter has its root in a play acted in 1601 by Cambridge students, and evidently written by one who had a particular acquaintance with the stage in the last years of Elizabeth. In the dialogue of the *Return from Parnassus, or the Scourge of Simony*, as this play was called, doubts are cast on the qualifications of student actors, one of them remarking that not only does Shakespeare confound their class, but Ben Jonson, too. However, he finds some consolation for this attack in the case of Jonson, for though, he says, "the pestilent fellow brought up Horace giving the Poets a pill . . . our fellow Shakespeare hath given him a purge that hath made him beray his credit."

The reference is undoubtedly to the war which raged from 1599 to 1601 between the player-poets and Jonson, caused by his method of satirizing the actors, as it is in one of the plays concerned that the character of Horace is introduced; but exactly what was Shakespeare's part in the quarrel has not hitherto been definitely determined. The solution adopted by Sir Sidney Lee, that the purge merely meant that Shakespeare had outstepped Jonson in popular esteem, takes no account of the graphic comparison with the emetic, while "beray" indicates to defile with filth. It seems, then, that Shakespeare's method was to caricature Jonson, in an illusion to some happening which was recent and notorious in 1601, as all the literary-dramatic world took part in the poets' war. From a study of the actors in the plays running at the time, it appears that Shakespeare withdrew from Jonson's *Every Man out of his Humour*, played at Christmas, 1599, but was again in the caste of *Sejanus*, a tragedy which Jonson presented later in 1603. The purge must therefore have been administered in a play performed between these dates, before a reconciliation had taken place; and the possible pieces reveal it in the person of Jacques, the melancholy figure in *As You Like It*.

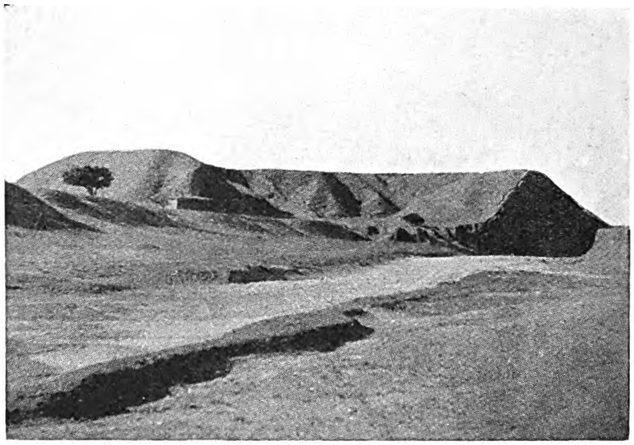
This discovery of Shakespeare as a partisan in an ephemeral quarrel, condescending to personal satire, is one which was quite unexpected. The book must be left to disclose the full story, but the interesting conclusion is drawn that Jacques stands for something more, and that it was against a new type of dramatic "humour" that Shakespeare directed his attack.

How the Modern Archæologist Works.

By Lt.-Com. Victor Trumper, R.N.R.

The many accounts of excavations appearing in DISCOVERY *deal primarily with specific finds in ancient history, rather than with detailed methods. Much interest therefore attaches to the following account of modern archaeologists at work, which is based on a typical expedition in Palestine.*

THE life and work of a professional excavator are often vaguely understood by the general public. From time to time news of sensational finds is made known in the Press, and so the popular idea of an excavator is one who goes to a place and digs up golden statues, priceless vases, marble urns, or the richly decorated mummies of the Pharaohs of antiquity. As a matter of fact, however, the modern excavator is looking for history rather than for objects of intrinsic value. If he finds any gold bars, so much the better, for they help to pay for the season's work. If he finds a beautiful piece of statuary, so much the better, for it sooner or later gets into the Press, interest is stimulated, and subscriptions to the work come along. The most sensational discoveries are sometimes a profound disappointment to the true archaeologist, as they may contain nothing that materially advances our knowledge of history.



THE SITE OF THE EXCAVATIONS.
Tell Jemmeh occupies a commanding position on the edge of a dry water course. Its name, also, suggested that it had been the site of previous occupations.

The archaeologists of a past generation enriched our museums to a large extent, for they often had virgin sites to work upon, but according to modern views they destroyed ten times more than they found. If only the modern trained archaeologist could have the sites and chances that they had, the science of archaeology would have been much further advanced than it is at present.

Recently I had the privilege of a short stay with Sir Flinders Petrie's expedition in southern Palestine, and was able to observe at first hand how the archaeologist works under modern conditions. A famous cookery-book recipe for jugged hare, which began "first catch your hare," may be adapted for archaeology, "first find a site"; and that is where knowledge, training, deductions, experience, flair, and the sixth sense come in. Anyone can dig with the possibility of finding something, but it is the successful expert who digs in the right place, and there are the thousand and one things, intangible to the lay mind, which guide him in the choice of a site.

The actual place was chosen by Professor Petrie for various reasons. It was an obvious "tell," which is the name given to desert mounds bearing traces of previous occupation. Then there was abundance of pottery about, but none later than Greek, showing that the site had not been occupied in Roman times. It was also near to Umm Jerrar, and the analogy with other sites in Palestine would lead one to suppose that it might be the city of Abimelech, King of Gerar, with whom the patriarchs Abraham and Isaac had dealings (see *Gen.* xx. and xxi.). It was also in a very fine strategical position, such as would be chosen for the capital. After the site had been decided, the next question was the permit from the Palestine Government. This was obtained, and happily the hill-top contained no cultivated ground. There were no rapacious owners to compensate, such as hampered the recent Palestine Exploration Fund excavations on the Hill Ophel outside Jerusalem; funds which ought to have been used for digging and publishing expenses, had there to be used to placate owners of cabbage patches, who, as soon as they found the land was wanted, immediately put an outrageous price on it.

As soon as the preliminaries were finished, two assistants were sent to the site to build huts. These were simply made of mother earth, kneaded up with water, exactly as were the bricks which were later found during excavations. The roofs were sheets of

corrugated iron. A low walled enclosure was made in front, half of which served as a drying and airing ground for clothes, the other half being used for the storage and sorting of pottery.

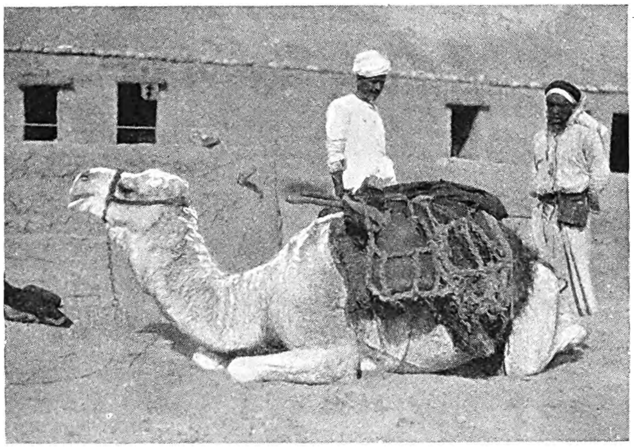
A word may be said here on the subject of water. As there had been a failure of rains in the district, the nearest well was about two miles away. This, however, was distinctly brackish, and was not rendered less so by the fact that a woman near, who was fearing a visit from the excise officers, dumped two bags of smuggled salt down the well! The main part of the drinking water had to be fetched by camel from Gaza, about nine miles distant. Later on, after some heavy rain, an old Roman cistern half a mile away filled up, and water for certain purposes was obtainable from that. The well in the vicinity supplied the water for the native labourers, who averaged about 350 men, and the Gaza water was used by the English staff, which numbered eight, including three ladies. If by any chance this supply failed and the staff were reduced to the use of the local water, there was no temptation to over-drink themselves, and one understood why good fresh water is always called in the Near East "sweet water." The supply of water for the expedition cost not less than a pound a week.

MUSTERING WORKMEN AT THE FOOT OF THE TELL.
Men were plenteous owing to a local drought having suspended agriculture, but there was difficulty in obtaining boys to work as carriers for the excavators.

The next thing was to recruit local labour, and in this case the task was not to get the men, but to refuse them. In that particular district south of Gaza, as mentioned before, there had been a complete failure of the winter rains, and the ground was so dry that ploughing was useless. Hence agriculture—the only occupation now that raiding neighbours is made unprofitable by the efficient police supervision—was at a complete standstill. In January, the time of which I am writing, the crops would normally have been about six inches high, but owing to the drought, the seed was not sown and the ground not even ploughed. The nearest water was the well two miles away, and the Bedawin had to lead their cattle and sheep daily to this place to keep them alive. They would be able to pick up a few blades of vegetation on the way. This statement can be taken quite literally, as I often watched the sheep, and it was quite a find if one blade of grass was within ten yards of another. Naturally after two or three weeks of this, the stock began to die, and an official computation estimated that thirty per cent of the cattle and sheep had been lost.

In view of this, it can be understood what a blessing the expedition was to the district, for to have from three to four hundred men and children in well-paid and regular work, at a time of great scarcity and stress, just meant the difference between subsistence and acute distress. The great difficulty was to get enough boys, for the arrangement is that one man digs, while one, two, or three boys, according to the distance, carry the earth away in small baskets to the dump. In this case the refuse could be thrown down the side of the hill, so there was seldom more than a fifty yards carry; but often in excavations the earth has to be taken even further, to avoid covering a place that might subsequently be wanted for operations. Unless there are enough boys to keep a man's digging clear, much time may be wasted.

Those in charge had to keep a sharp eye to see that men who had not been taken on did not mix themselves up with a gang, and so work for a day, claiming a day's pay under the plea that they had really been engaged but their name had been omitted from the pay-book. If one of the assistants noticed a man working particularly hard when he passed by, that man was closely interrogated, which frequently resulted in his being sent off, generally amid the mocking laughter of the other more fortunate ones. It was not pleasant to have to refuse men, who were really anxious and willing to work, and were on the borderline of starvation, but the funds of the expedition did not permit of indiscriminate payments, and unless there had been very strict and efficient supervision, the result would have been chaos. Practically all the locally recruited men had never done archaeological digging before, and so half a dozen trained Egyptian workmen had been brought for the more delicate jobs. It may be mentioned that some of these men were



ARRIVAL OF THE WATER SUPPLY.
Water for the English staff of eight archaeologists had to be brought by camel from Gaza, a distance of nine miles, as local supplies were brackish.

the grandsons of those who had worked for Professor Petrie when he first came to Egypt about forty years ago.

The system of payment was that a man received a full day labourer's wage, and he was also paid full value for any small objects that he found. This has been proved the most satisfactory method of working, for the workman gets the cash and the excavator gets the object. In the diggings undertaken by the Egyptian government no compensation for finds is given to the workman; as a consequence any excavation attracts numbers of illicit dealers, who buy the objects from the workmen, and the government get few of the finds except those that are impossible to conceal. Under Professor Petrie the workman gets the value in any case, but if he sells it to the dealer, he is promptly discharged. Naturally he prefers to keep a well-paid and steady job, and also this system makes for care with fragile articles, for it is soon learnt that broken fragments are worth less than a whole pot or vase.

The Palestine men had not been used to this sort of treatment, and when they were first told that they would receive so much for small objects found, according to the value, there was a pleased smile not unmixed with incredulity; but when on pay night every man got his full pay, and those who had been lucky or careful enough to find objects of archaeological value got the extra money as well, their faces were a study.

As already mentioned, the hill known locally as Tell Jemmeh was in a very commanding position, on the edge of a "wady" or dry watercourse, with no other high land within several miles, so that the view from the top was extensive. As a fortress it could dominate the southern entrance to the Palestine maritime plain. Work was commenced at the top on the north-west side, as that appeared the most promising, and within a day or two discoveries proved the accuracy of this forecast; walls began to appear, and in a few weeks it was possible to discern complexes of rooms. However, the problems were many, and the fact that the site must have been in occupation for several hundred years, and that the successive inhabitants had either built on, or dug into, their predecessor's houses, did not lessen the general confusion. Among the first finds were some more or less circular pits. These appeared to be made in the thickness of a wall, and at first seemed to be specially constructed grain stores, with an opening in the bottom to withdraw the grain into the room. Further excavation revealed the fact that while they were undoubtedly grain pits, they had been sunk at random after the room had been filled up. The people who made them probably knew little, and cared less, that they were digging into massive walls of mud brick, six or seven feet thick. Ten large round, shallow, plastered pits were found.

The walls of mud brick furnished many problems. It must be remembered that the bricks were formed of sun-dried mud from the ground on which they were built, and the mortar used was the same mud. Then, after the walls of a chamber had been weathered away to a few feet of their original height and the debris washed into the room, it was filled up by blown sand and dust, consolidated by hundreds of rainy seasons. Finally, as it had also been built over by successive peoples whose architectural methods were the same, it was difficult to trace the original wall, and one might easily dig through brickwork without knowing it.

WALLS UNEARTHED ON THE TELL.
The author explains the procedure in excavating these walls, which were made of mud bricks and hence readily confused with the soil.

When a wall was discovered it was carefully followed by one of the trained Egyptian workmen, who knew by long experience what was brickwork and what was simply silt.

While the top was being excavated and fresh problems were presenting themselves, the sides of the hill were thoroughly explored, and eventually work was commenced on an outlying spur.

A doctor who had kindly volunteered his help was kept busy not only with the minor hurts incidental to the excavations, but with the Bedawin from the district, who used to come with many and varied ailments. Not the least part of his work, however, was the examination of the burials found on and around the mound. As soon as bones were discovered, one of the Egyptian workmen was put on to clear the earth as much as possible. Then the doctor would come with callipers and tape to take careful measurements, especially of the skull, before anything was moved. Sometimes, in spite of every care, the skull fell to pieces in the process. One remarkably fine skull, before being moved, was covered with a layer of melted paraffin wax, which solidified and made a support, enabling the skull to be lifted. Then the dirt from inside was carefully removed, and a thick layer of wax was poured in; the outer layer was peeled off and then measurements could be taken. These showed that the cubic contents of the skull were 1750, whereas the average European skull of to-day only gives 1550.

Needless to say, constant supervision was necessary, and the Professor's assistants were kept hard at it—directing the digging, seeing that each man had his proportion of boys, and watching carefully when any new feature presented itself, such as a change of colour

WAXING A SKULL.
This process is employed in order to facilitate removal of skulls which are often discovered in decayed condition.

MORE DISOVERIES ON THE TELL.
These semi-circular niches were part of a complex of structures that may have been guard-rooms and look-outs on the top of the tell.

of the earth or change of slope of the stratification. All the broken pottery dug out was carefully separated, at intervals being sent down in baskets to the enclosure in front of the huts, and put in piles according to the part of the excavations from which it came. The staff would go through these piles of broken pottery, carefully brushing each piece to see if there were any characteristic ornamentations that would date it, or any inscribed pieces usually known as ostraka—a tedious but very necessary job, if all the evidence is to be garnered. A dated piece of pottery and its exact place of provenance may give the clue, sought for several weeks, to the meaning of walls and their destruction.

One day a little skeleton was discovered in the digging, and while the bones were carefully lifted out, someone's sharp eye noticed a minute bead. Immediately one of the Egyptian workmen was called and a boy was sent post haste to the huts at the foot of the hill for a fine sieve; all the earth was put through it, and there was recovered a whole necklace. It was of small intrinsic value, but a pathetic reminder of some mother's love and care in a far off age.

Photographing, planning, and taking levels are most important parts of modern archaeological work, too often neglected in the past, and sometimes even now neglected. Only with true relative levels, careful photographs, and accurate plans, can correct deductions be made and opinions formed, for when a site is fully excavated the concrete evidence lies in the record. When sandstorms or heavy rains occur, which prevent outdoor work, the staff are busy piecing broken pottery together, making scale drawings of all the objects found, discussing their significance, and elaborating future plans.

Industrial Uses of Ultra-Violet Light.

By L. V. Dodds.

Ultra-violet light is finding increasing application in the chemical and other industries. Its use in examining documents and paintings provides a new weapon to supplement the X-ray.

MANY exaggerated claims have been made for the artificial sunlight lamps now used so extensively, yet some remarkable results have been obtained both in the therapeutic and technical use of this new science. The medicinal value of ultra-violet light has been discussed in *Discovery** already ; and many industrial processes, especially those in which chemicals are employed, are also being assisted by the light, which both increases and accelerates ordinary chemical action.

Ultra-violet light is invisible. Both this and visible light are measured in Angström Units, one A.U. being the length of the largest X-ray or one ten-thousandth of a millimetre. Visible light ranges from 7,500 A.U. to 3,900 A.U., and that portion of the ultra-violet group which is most biologically active lies between 3,000 A.U. and 2,000 A.U., most of which is not obtainable from natural sunlight, due in England to the pollution of the atmosphere. A recent report of the Medical Research Council states that " the acetone-blue gauge shows that, on the average, two-thirds of the ultra-violet rays are cut off by smoke and dust pollution of the atmosphere in the city of London." Ordinary window glass cannot transmit rays shorter than 3,000 A.U., so that those of most value to health are eliminated entirely. " Vitaglass," however, a material invented by Mr. F. E. Lamplough to replace window glass in all its uses, will transmit as much as eighty per cent of the essential rays from the sun, and this is now being used extensively in hospitals, solaria, and private homes.

Production of Rays.

There are various methods of generating these rays artificially, and the one used most extensively, chiefly owing to its comparatively low cost and convenient method of working, is by means of the mercury arc quartz lamp. To describe the process briefly, a direct current of electricity is passed through the vapour of molten mercury contained in a vacuum quartz generator, and electrons in the form of ultra-violet energy are driven off similarly to X-rays. Quartz will transmit all the rays and also resist the heat. This principle governs all lamps of this type, though the fitments and attachments vary considerably according to the use to which the lamp is applied. The glaring light which appears when a sunlight lamp is operated is of no material value, and it is possible to eliminate this altogether by using specially constructed filters. Thus, when the lamp is switched on, nothing happens to all appearances, yet a powerful, unseen beam of ultra-violet energy is created which is being used now in many different ways.

Photography in Darkness.

The ability to take a photograph in total darkness is possibly not of great practical value, but it instances one of the curious ways in which ultra-violet light can be used. A photographic plate is very sensitive to the radiations, and in ordinary daylight photography it is often necessary to use colour filters over the camera lens to reduce or intensify the action of the rays from the sun. When the mercury arc quartz lamp is used, however, the energy created is four times more powerful than that produced by the sun in England, and, in consequence, the action on the plate is greatly increased, so much so, that visible light becomes of such secondary importance that it can be eliminated completely.

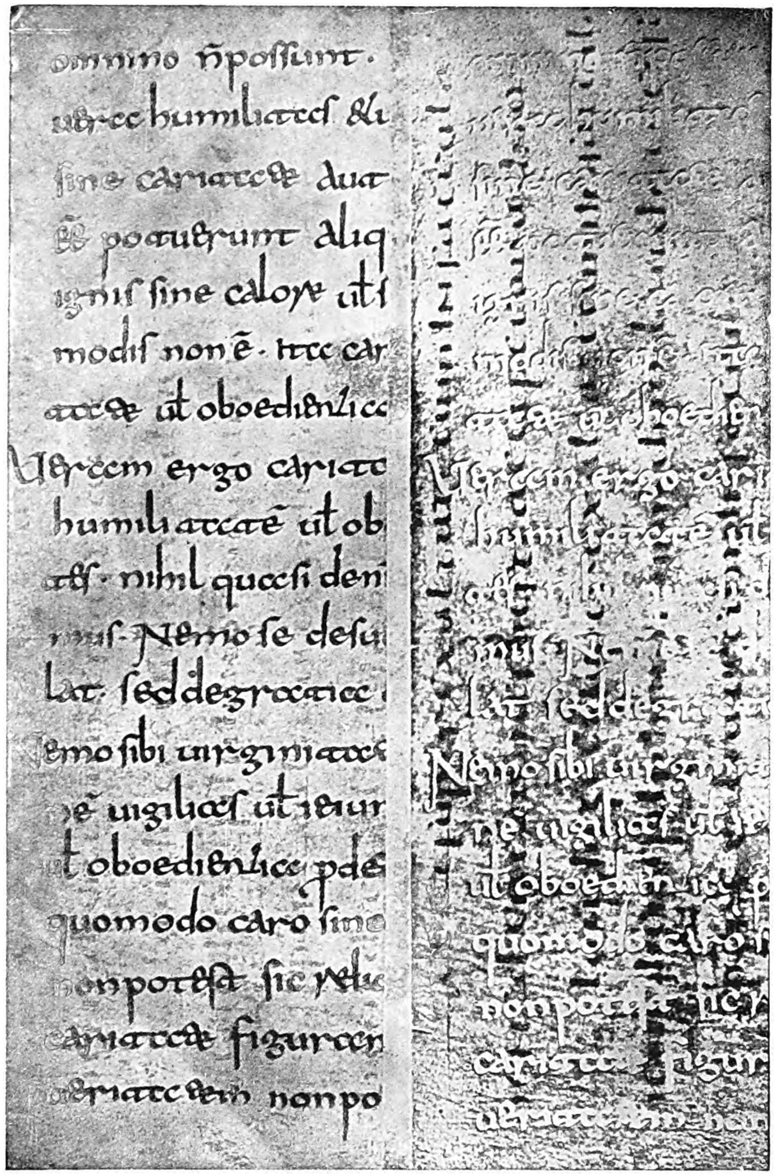
To make an exposure in total darkness, an ordinary camera fitted with a quartz lens is focussed on to the desired object and the line of the lamp beam is similarly directed. All illuminations are put out, and when the lamp is operated the visible light is filtered away and a simple instantaneous exposure made with the camera. After development a negative is obtained quite equal to one which is taken with magnesium or similar illuminant. Eyesight is very sensitive to the radiations, and if a figure is included in the picture the eyes should remain closed throughout the exposure to avoid injury. A single experience may not be harmful, but as some eyes are affected to a greater degree than others, it is advisable to take no risk. The operator wears the usual type of goggles made for the purpose.

An adaptation of this method is used in the making of micro-photographs in metallurgy. Difficulty is often experienced in focussing, which has to be done by means of a fluorescence screen and must be very exact. The advantage of using ultra-violet light in this way lies in the fact that some of the constituents

* " Recent Developments in Ultra-Violet Irradiation." By C. A. Cooper. February, 1928.

of steel, which look very much alike when photographed by ordinary light, absorb ultra-violet light selectively, and so appear sharply differentiated when the micrograph is made under this illumination.

Most important of modern experiments with invisible sunlight is the discovery of fluorescence. American scientists have stated that every known substance will show a fluorescence under ultra-violet light, and that the unknown can be determined by comparison with the known. Whether this is true for every substance has not yet been proved, but it is quite certain that a very large number of substances do show this fluorescence, which appears as a curiously glowing light varying in colour according to the material examined. A special screen is used for noting this phenomenon, consisting of an arrangement of coloured glass coated with a gelatine film containing a chemical substance in solution, to which a solution of another substance in water is sometimes added. Only radiations between 3,300 A.U. and 3,400 A.U. can pass through this screen, and these, of course, are invisible. The best known of such filters is the Wood filter, in which copper sulphate and a deep orange dye, nitroso-dimethyl-aniline, are used. Recent experiments have produced a screen of deep black, which it is claimed will supercede other filters by its more convenient method of manufacture and working. When the rays strike a substance capable of fluorescing, the short wave-lengths are changed into visible light of longer wave-length, and the curious glow is seen which is known as fluorescence. By noting the colour variations it is possible to identify like substances with absolute accuracy in many instances, and this method has already had numerous practical results which are extremely interesting.



[*Photograph by courtesy of Prof. G. R. Kogel.*

PALIMPSEST PHOTOGRAPHY.

On the left is a manuscript photographed in daylight, and on the right the same under filtered ultra-violet light, showing the older writing underneath.

Germany has adopted the new method enthusiastically, and all the large banks and police stations have apparatus installed for use in criminal investigation. In 1926 the German banks found that a large number of foreign railway bonds had been so falsified as to antedate their maturity and so increase their apparent value. The alterations were done perfectly, but they were obvious at once under ultra-violet light by the various inks used fluorescing differently. None of the bonds in question were accepted until they had been submitted to the test, and a very large sum of money was saved. In cases of arsenical poisoning the presence of the drug can be found, no matter by what foreign substances it may be surrounded, and in a recent important trial in Berlin a fluorescence test for arsenic was admitted as evidence for the prosecution.

The Bank of England has apparatus for testing counterfeit bank notes, while both Scotland Yard and many large jewellery establishments examine suspected gems beneath the light. Diamonds glow like beautiful

blue lamps, but imitations are absolutely lifeless and dull. Criminology has a very potent weapon available in invisible sunlight, and a well-known authority has declared that for this purpose ultra-violet lamps are more serviceable than a microscope.

In olden times when parchment was used to write on, it was not thrown away when time had made the document worthless because of the expense of producing the material. Instead, it was carefully cleaned by chemical or mechanical means, and used a second and even a third time. In many cases the more ancient writings would be of much greater historical value if it were possible to read them, and, now, by the use of the Hanovia analytic quartz lamp, they can be deciphered. Even after the removal of the original writing traces of tints and dyes were left in the parchment, and under ultra-violet light these show different fluorescences from the parchment itself, and also from the later tints, which can be removed or neutralized by the use of certain photographic colour filters. When a photograph of the parchment is taken under the rays, the superimposed writings appear as if in outline type, that is, having a white ground and a thin, black edge to the lettering. Underneath this can be seen clearly the original script, which is dark grey in colour. Certain imperfections must be expected due to the varying action of the cleaning process, but it is seldom that there are any difficulties in deciphering due to visibility. By this means important material for the study of history has been produced which was unavailable hitherto.

Textiles and Silk.

Textile manufacturers use ultra-violet light for separating fabrics much alike but actually different, while mildew and bacteriological damage can be detected. The health of silk worms may not appear to be an important matter, but upon it is dependant the quality of the silk produced. Many breeders periodically test the worms by fluorescence and pick out any unhealthy ones, thus keeping the strain good. The secreting organ of a healthy silk worm fluoresces white, while the blood shows a yellow fluorescence, any variations in colour denoting an unhealthy insect. The possibilities of this test being applicable to the human body also may be among future developments.

For some time past hospitals have exposed all the milk used to ultra-violet light, which produces complete sterilization and is also said to increase the calcium content of the milk. Many researches are being made regarding the irradiation of foodstuffs, and some have already been placed on the market on a commercial scale. Butter is sterilized by being spread out on an endless band which passes before a sunlight lamp. There is a slight change in chemical composition, but very little difference in colour or taste. Butter oils, cod liver oil, and others containing anti-rachtic vitamins emit a yellow fluorescence, while inactive oils, such as olive oil and pea-nut oil, show white. When the latter are exposed to strong ultra-violet light they gradually show a yellow fluorescence which deepens in colour according to the intensity of the rays. This is said to prove definitely the food value of such irradiations.

A Sensitive Test.

Fluorescence tests for the presence of some particular materials are possible to an extraordinary degree of accuracy. Naturally some substances fluoresce more than others, and quinine is specially sensitive, being found even in water solutions of 1 part in 100,000,000. Uranin is more sensitive still at 1 in 1,000,000,000, and in the case of aesculin even 1 part in 10,000 millions can, under favourable circumstances, be detected by its distinct fluorescence. A method of investigation is now available which in its precision approaches the spectroscope.

Various methods have been evolved for measuring the intensity of ultra-violet light, which has formed one of the principal difficulties to successful use in commercial enterprises. Professor Leonard Hill, F.R.S., invented the infusoria killing test and the power was measured in I.K. units. He was responsible also for the methylene-blue test which is bleached under the action of ultra-violet light. This method is used in the British meteorological records. The convenient uviometer seems to be a solution of this difficulty, and its invention by McKenzie and King has done much to increase the accuracy of ultra-violet light treatment, especially in therapeutic and bacteriological uses. This apparatus is based on the freeing of chlorine from carbon tretrachloride, and a colour comparison is made between a set of standard tinted specimens of carbon tetrachloride which are built into the machine.

The ways in which artificially generated ultra-violet light can be applied are extraordinarily varied. In the arts, in chemical analysis, in medicine and in technical processes in industry new methods for using apparatus are constantly being discovered, and in consequence the rays become of ever-increasing importance. Much of the work in this new branch of research is still experimental, but sufficiently successful results have already been obtained to prove that the application of artificial ultra-violet light is one of the outstanding achievements of science.

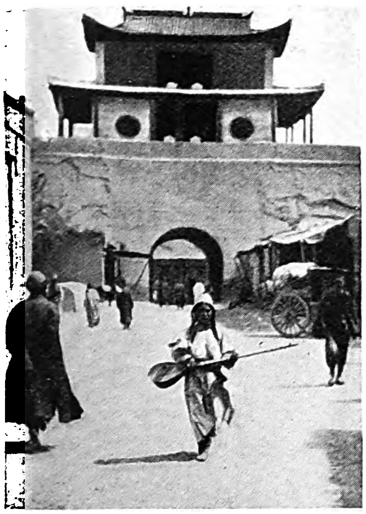
Ordam Padshah, A Second Mecca.

By Lt.-Col. P. T. Etherton,

Late H.M. Consul-General in Chinese Turkistan.

Although Ordam Padshah is visited by pilgrims from all over Asia, so far as is known only five white men have ever journeyed to this sacred shrine. The author enjoyed this experience while in Turkistan.

HIDDEN away in the heart of Asia, amidst a wilderness of shifting sandhills, some of them two hundred feet in height, lies the shrine of Ordam Padshah, second only to Mecca in Moslem eyes. Pilgrims flock to it from all parts of Asia, but during just on a thousand years only five white men have penetrated to this sacred spot. Apart from the antipathy shown to Europeans visiting Moslem shrines of so exceptional a nature, the physical difficulties to be overcome are formidable in the constantly moving sea of sand which has in the past engulfed forests and filled up large rivers.



THE GATE OF YANGI HISSAR.

Ordam Padshah is about ninety miles north-east of Yarkand in Chinese Turkistan, and it marks the spot where the historic battle took place ten centuries ago for supremacy between the rival religions of Mohammed and the Buddha, in which the Buddhists were defeated, thenceforth the Moslems becoming the predominant religious element in Central Asia. There is a total of 730,000,000 Moslems and Buddhists in the world, so the magnitude of the struggle, and the issues at stake, can be well imagined.

Yarkand is a city of the Arabian Nights, and the glamour of romance hangs over it from its association with the greatest story-book of all times. Seventy miles north of this city of Sinbad the Sailor and Aladdin's Lamp is Yangi Hissar, whence I set out to reach Ordam Padshah. For the expedition I was accompanied by the Chief Beg, or official in charge of the district, and a mixed following of soldiers and servants, the Moslem leaders—contrary to predictions—raising no objection to my journey. Since the war the British attitude towards Moslems generally, and our protection of the Holy Places, had created a profound impression, this being probably the reason why the project was not opposed and fanaticism for the time being was put on one side.

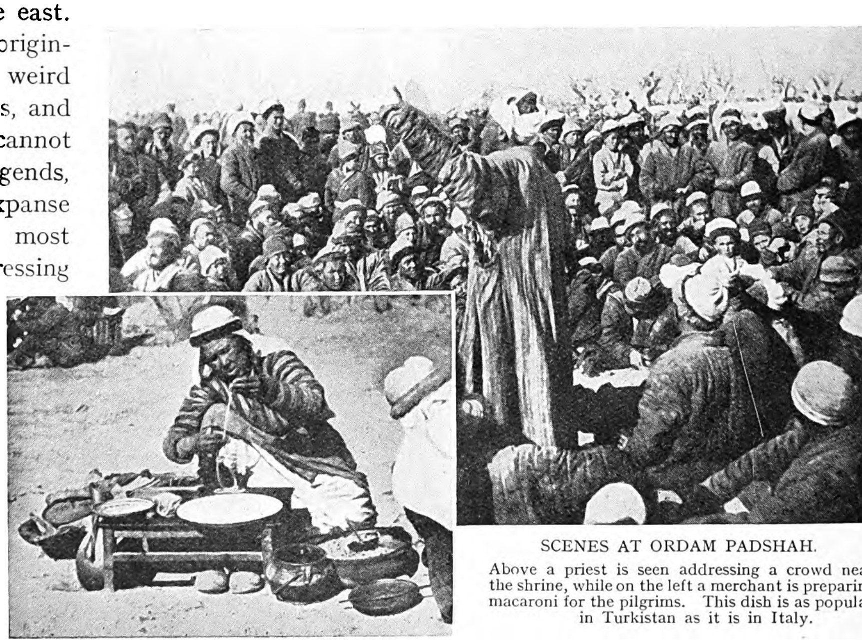
On arrival in Yangi Hissar I dined with the Chinese governor. The meal was a regular banquet; we were served with Chinese delicacies such as shark's fins, bamboo roots, seaweed, fermented eggs, stag's tendons, sea slugs with at least a hundred legs, lotus seeds, pork crackling, eggs preserved in chalk—the older the egg the greater its edible value—duck's brains and grilled rats. A grilled rat restores the hair when you are bald, whilst a stewed black cat will ward off a fever. The *pièce de résistance*, however, was a number of newly-born white mice served alive, to be dipped in treacle and swallowed whole like a prairie oyster. I have eaten the food of over thirty different countries, but I could not face the mice, and the host was much upset, remarking that I didn't know a good thing when I saw it!

EAGLES USED BY PRIESTS FOR HUNTING.

Ordam Padshah is one of the few places where these birds are still used for hunting, the pastime being a popular one with the priests.

This dinner afforded a quaint study in human nature as seen in little-known regions of the earth. A Chinese general of high rank was also dining, and on taking his place at table gave his richly-jewelled and bedecked head-dress to an attendant behind his chair. The latter had his hands occupied with a rifle and sword, so cast around for a peg on which to hang his master's magnificent hat, but not perceiving anything suitable he promptly put it on his own head, and there it remained until the general left.

On leaving Yangi Hissar the track passes through an oasis and then becomes lost in the immense desert of shifting sand that stretches for two thousand miles across Asia to the east. This desert has originated all sorts of weird and ghostly stories, and certainly one cannot marvel at the legends, for the endless expanse of sand has a most dismal and depressing effect. There is no sign of human, animal, or vegetable life, not a sound of beast or bird, nothing to relieve the sepulchral silence. The formation of the sandhills is always the same, successive rows one behind the other often as much as two hundred feet in height. They are continually pouring in from the east with successive storms, which rage with great violence in this area. On leaving the oasis we plunged immediately into this sea of sand, the going being exhausting: for every step sinks in to the knees and often up to the waist. All day long we struggled over these sandhills until nightfall of the first day found us in a small clearing in the wilderness, a tiny island, so to speak, of reed and mud-built huts. This was the advanced outpost and first contact with the mysterious shrine of Ordam Padshah, for here lives one of the priests and his assistants who supervise the pilgrim traffic. I had a long talk with them in their own language, and they showed me some magnificent eagles that are used to bring down wild boar and gazelle, this being one of the few places in the world where eagles are still used for hunting purposes.



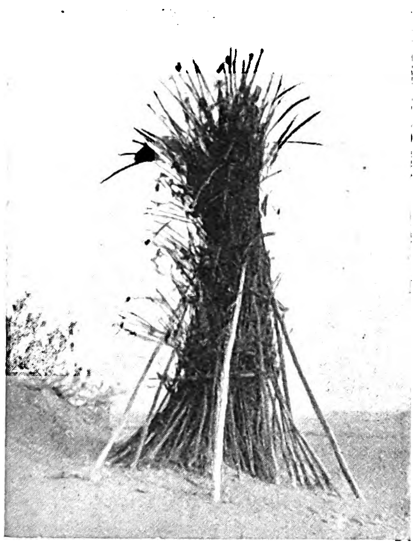
SCENES AT ORDAM PADSHAH.
Above a priest is seen addressing a crowd near the shrine, while on the left a merchant is preparing macaroni for the pilgrims. This dish is as popular in Turkistan as it is in Italy.

The fast of the Ramazan, the greatest religious observance of the Mohammedan faith, had recently ended, and I learnt many curious details about it. The fast is for thirty days, and no food whatever must be taken between dawn and nightfall. It is null and void if perfumes are smelt, and there must be no form of material pleasure during the prescribed hours. The true believer must not swallow his saliva, and the very orthodox ones will not open the mouth to speak for fear of breathing more air than is essential. During the hours of complete darkness eating is permitted, but no particle of food must be left in the mouth, for even a grain of rice between the teeth is sufficient to destroy the fast and the reward in the hereafter is decreased. A Mohammedan must not touch a woman, and to kiss her is disastrous.

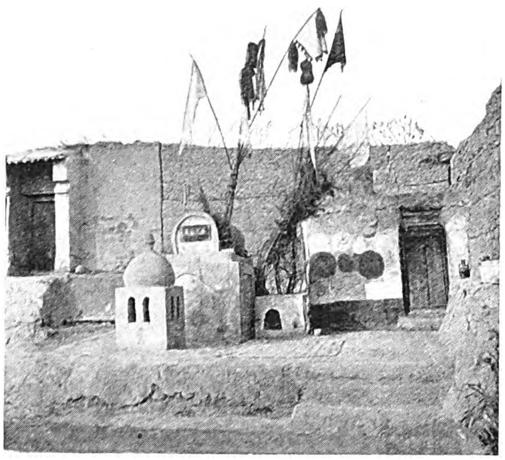
The next morning I set out on the final stage that took me to the shrine. Once more we struggled over countless sand dunes, the average height of these moving hills being about one hundred feet. Late that afternoon the guide said we were nearing Ordam Padshah; we were tackling an exceptionally lofty sandhill and at last reached its summit. From this vantage point I saw Ordam Padshah (My King's Palace), a collection of some twenty houses and a mosque, near to which was the most curious religious monument in the world, for it marks the spot where the leader of the Mohammedan army fell with many of his best warriors. It is a sheaf of sticks and poles sixty feet in height and over one hundred feet in circumference at the base. The sticks have been deposited by successive generations of pilgrims, and the wealthy amongst them deposit poles and beams of large size brought with infinite labour from all over Asia. My followers were awed and deeply impressed at the sight of this sacred spot. We moved slowly down the sandhill to the outskirts of the settlement, where I was met by the chief priest and his following.

They were quite friendly, and the sheikh himself, with a long white beard and venerable appearance, made a most impressive figure. He led me through huge walls of sand to the guest chamber, a small two-roomed house raised about six feet above ground level with a platform of beaten earth.

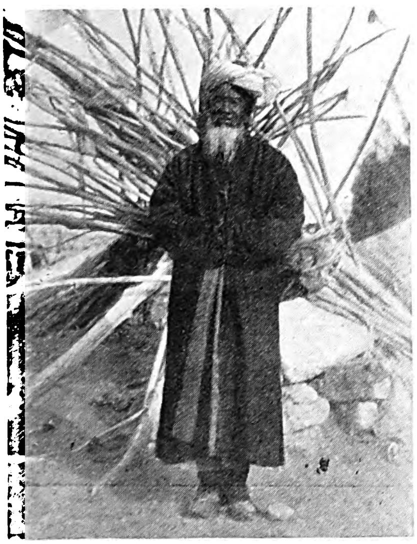
Night was already closing in, and after a "dasturkhan," or feast, laid out on the floor, of dried fruit, nuts, roast mutton, meat dumplings, and a variety of cakes, the high priest left me, saying as he went out, "Venture not from your chamber until the dawn, for the spirits of the lost pass up and down in the still hours of the night and it is death to hear them." So I stood fast and the next morning in broad daylight went out on a tour of the place. The permanent staff consists of the chief priest and about seventeen subordinates, and the houses in which they live are hemmed in on every side by a wilderness of shifting sand. The principal religious building is that used for the reception of offerings brought by the faithful. I saw here and in an annexe the most wonderful collection of carpets, brocades, gold and silver ornaments, precious stones, jade, and other articles which we usually associate with the Arabian Nights. There were five bowls set apart for the votive offerings, the largest of bronze, six feet deep and five feet in diameter at the top, said to have been cast in the days of the Mohammedan champion himself—a thousand years ago. Apart from its size and intrinsic value, its contents in the height of the pilgrim season can be imagined, and I thought what a "lucky dip" it would make. Another bowl was of copper, of about the same size and capacity, and was brought here with infinite difficulty by a famous Amir of Central Asia who made no fewer than three pilgrimages to this sacred spot. He was the most noted character in Asiatic history, and when at the zenith of his power maintained a large personal household, including a harem of three hundred women.



THE SACRED SHEAF.
This remarkable religious monument, over fifty feet high, is composed of poles brought by pilgrims from all over Asia.



THE MOSQUE AT ORDAM PADSHAH.



THE MOSLEM HIGH PRIEST.
This official conducts the religious rites at the mosque. Behind him are further offerings.

On one day during the pilgrim season the huge bowls are used for cooking purposes, and "pilau," a form of mutton, rice, vegetables, and spices, is prepared for the vast host of devotees. The bronze bowl is in greatest favour from its age and sacred association with the Mohammedan leader, and great is the competition to secure a morsel of the contents for not only does it cleanse from unrighteousness, but carries with it a passport to Paradise.

The crowd was a highly cosmopolitan one, and more than twenty different tribes and races of Mohammedan Asia were represented. There were many Wakhis, whose spiritual head is that well-known figure the Aga Khan. It is curious to think that this wild and remote people, whose lives are passed amongst the biggest peaks and glaciers in the world, should have as their head the genial sportsman so familiar to English racing and social circles.

Much more I saw in Ordam Padshah, and on leaving I commented on the fact that the place has escaped being swallowed up by the sand. It really is remarkable, but the chief priest replied dramatically, "The sand will not touch the resting-place of the holy martyr; it passes on in its course, giving peace to the sacred spot and it will do so to all eternity."

The Great Californian Dam Disaster.

By R. C. S. Walters, B.Sc., A.M.Inst.C.E.

That the difficulties in the construction of a dam are not generally realized, even by engineers, is borne out by the collapse of a newly-built dam in California. The facts suggest that further research is required.

THE report of the commission of engineers appointed by the Governor of California, U.S.A., to inquire into the great St. Francis dam disaster has now been published. The dam was built in 1924-5 across the San Francisquito Canyon, some forty-five miles north of Los Angeles, and formed a storage reservoir for the water supply of the city. This reservoir was filled to about three-quarters the height of the dam from March 1926 to March 1927, and from then until the disaster this year the water-level was at or near the top of the dam (Fig. 1).

The structure collapsed suddenly at midnight on 12th March. The dam retained a depth of water of nearly 200 feet and a volume of 38,000 acre-feet, which was suddenly released into the valley below. The San Francisquito Canyon, as it is called, is comparatively narrow for a distance of some ten miles, and then joins the Santa Clara River, situated in a wide valley in the Ventura country. From this point the river flows westwards for some fifty miles to the sea, and along its course there are several small cities and a railway. Los Angeles itself, however, is some forty miles from this valley.

When the burst took place the flood swept through the canyon with a depth of 75 to 125 feet. The sides of the canyon were swept clean (Fig. 2), and blocks of the dam were carried for miles down the valley; thus a block weighing perhaps two or three thousand tons was taken for nearly half a mile below the dam. When the flood emerged from the relatively narrow canyon into the Santa Clara valley, which is over a mile wide, the depth of water and the rate at which it travelled was much lessened; but a vast amount of damage (estimated at £4,000,000) was done by reason of towns being inundated, bridges swept away, railways and roads torn up, and water-works and sewage works being destroyed. In one instance a bridge, formerly spanning a channel 150 feet wide, was completely obliterated, and the channel itself enlarged to a width of 500 feet. In another case, a railway track with sleepers was transported a hundred yards and turned upside down. The water took some three hours to

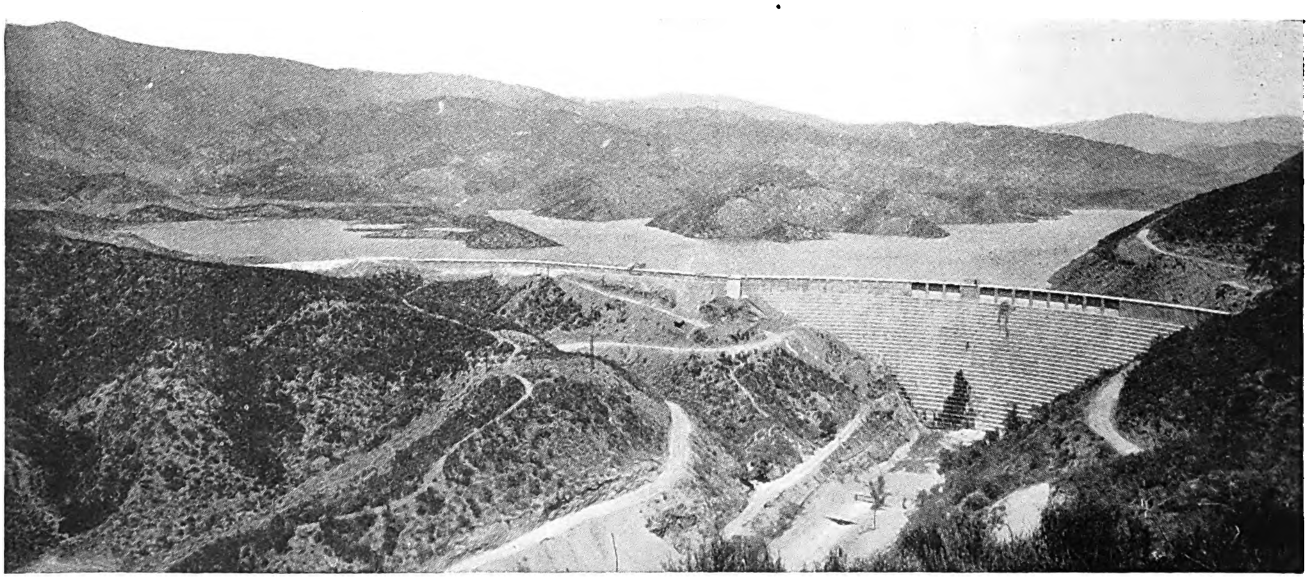


FIG. 1.

VIEW OF THE ST. FRANCIS DAM BEFORE THE DISASTER.

This concrete dam was 700 ft. in length, constructed in a concave curve having a radius of 500 ft. The first break took place in the portion seen on the left (*i.e.*, right bank side). This and the other photographs are reproduced by courtesy of *Engineering*, London.

travel forty-five miles. The loss of life was over four hundred, nearly half of which appears to be accounted for by those who were in the construction camp a few miles below the dam.

According to details in the American *Engineering News Record*, the dam was constructed of mass-concrete and was curved on plan, having a radius of 500 feet. The maximum height was 206 feet above the ground level of the bottom of the valley, and the width 176 feet. The total length was 700 feet. After the failure, a central portion measuring 75 feet (of the 700 feet) is still standing, but on the north-west side (left hand of Fig. 3), there is a great gap where 250 feet of the dam was completely removed. On the south-east side there is another great gap of about the same size. No trace whatever remains near the dam of any concrete that filled the left-hand gap, but most of the concrete from the right-hand gap remains in a broken condition at the foot of the dam; from this it is inferred that the left-hand side gave way first, a fact which the commissioners definitely attribute to defective foundations.

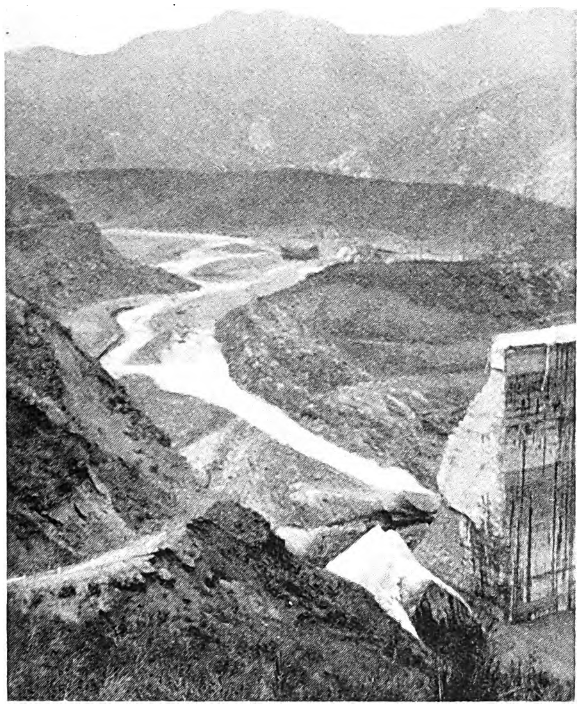


Fig. 2.
THE CANYON AFTER THE BREAK.
Looking down stream, the high-water mark of the outflowing water is clearly seen along the hills on both sides of the valley.

The dam is built upon a line of a geological fault between conglomerate, a rock composed of pebbles cemented together, and schist, a laminated rock of a slaty nature. The conglomerate is composed of small pebbles, which are embedded in a sandy micaceous detritus, and when dry it appears to be hard, though by no means good for a foundation. This is shown by laboratory crushing tests (500 lb. per sq. inch) and by the fact that when a piece of the rock is placed in water "a startling change takes place. Absorption proceeds rapidly, air-bubbles are given off, flakes and particles begin to fall from the sides of the immersed piece, and the water becomes turbid with suspended clay. In usually from fifteen minutes to an hour a piece the size of an orange has disintegrated into a deposit of loose sand and small fragments covered by muddy water. . . . Clearly, when thoroughly wet, the conglomerate at the north-western abutment (right bank) of the dam ceased to have the characteristics commonly denoted by the term rock."

It seems that water would penetrate easily through this rock under the concrete of the dam, especially in the vicinity of the fault. As the concrete was only taken down some eight or ten feet at this point, the hillside would rapidly disintegrate (as illustrated above in the small scale experiment), and would leave the great mass of the concrete of the dam unsupported. This concrete would break off along the planes of contraction.

The dam at the south-east end (left bank) is built upon schist. The strike is parallel to the course of the canyon and the dip is north-westerly. The laminations of the schist on the left bank may be likened to slates on the highly inclined roof of a house, hence the schist is naturally liable to slip, especially when the pressure from the dam is parallel to the planes of lamination. When the left bank collapsed an immense volume of water would scour into the schist and cause it to slide. This left the underside of the dam without support and caused it to shear out, bottom first, and fall on its upstream face (see Fig. 3).

The mere fact of the central and highest part of the dam having stood practically without movement shows that its design, construction, and foundations are right. Excavation for the latter was carried thirty feet below ground for this central and highest part, but, as stated above, the excavation for the sides was not so deep. Nevertheless, owing to the great wrenches of the two ends being sheared from it, the top has moved some eight and a half inches, presumably downstream. There is an automatic recorder on top of the standing portion of the dam, which would show the rate the dam emptied, but at present figures are not to hand.

The summing up of the commission is contained in three clauses: "(1) Failure of the St. Francis dam

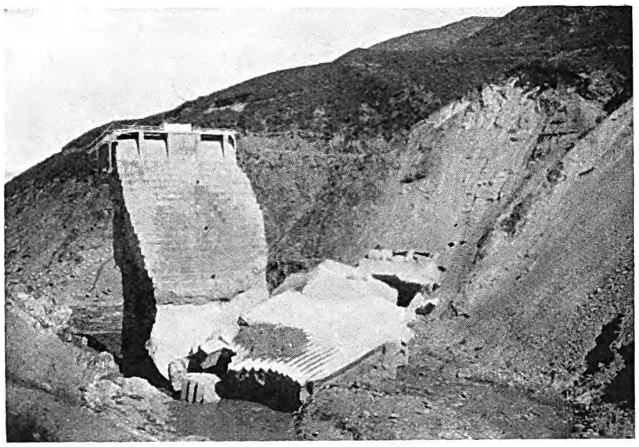


FIG. 3.
REMAINS OF THE DAM.
The remaining middle portion and fragments of the east wing, view up-stream.

was due to defective foundations. (2) There is nothing in the failure to indicate that the accepted theory of gravity dam section is in error, or that there is any question about the safety of concrete dams designed in accordance with that theory when built upon even ordinarily sound bed-rock. On the contrary, the action of the middle section, which remains standing even under such adverse conditions, is most convincing evidence of the stability of such structures when built upon firm or desirable bed-rock. (3) The failure of this dam indicates the desirability of having all such structures erected and maintained under the control and supervision of state authorities. . . . The disaster emphasizes the fact that, while the benefits accrue to the builders of such projects, the failures bring disaster to others who have no control over the design, construction, and maintenance of the works. The police power of the state certainly ought to be extended to cover all structures impounding any considerable quantity of water."

The geological and engineering difficulties in dam construction are not generally realized, even by engineers. The construction of a successful dam is the most difficult piece of engineering there is. Perhaps more disasters have occurred by the collapse of dams than by any other engineering structures. Not only should dams be constructed under the best geological guidance, but also they should be watched for signs after they are built. An engineer who has never had experience of a dam will gaily undertake its construction, imagining that it is the easiest thing in the world to throw an earth or concrete bank across a valley. To illustrate the difficulties involved, the case may be taken of an earthen dam with a core of puddled clay. In practice the parapet wall has sunk, this fact showing that the materials forming the bank have consolidated by the great pressure upon them, and the top of the bank is nearer the water-level than it was when the dam was built some forty years ago. Hence there may be a risk during a great storm—such as may occur once a century—of the water overflowing the top of the dam; in which case, of course, the soft earth and clay forming the bank would be quickly washed away, from the top downwards, until the whole dam would be demolished and the reservoir emptied.

An example of such a disaster took place at Johnstown, Pennsylvania, in 1889, when more than two thousand people lost their lives. This dam, built in 1840, was 930 feet long and 75 feet high; there was no central puddled clay in the dam, but the materials were made up of "impervious soil, rock, gravel, and sand-fill." The dam had remained sound for fifty years, but had not been watched; and the failure was due to a large flood overtopping the crest, contributed to by "a lowering and dishing of the crest, together with obstruction of the spillway." Other such failures include the case of the Dolgarrog dam in North Wales, in November, 1926. This dam was 3,300 feet long and 20 feet high, with footings 18 inches only in the clay. The foundation was scoured out, and the volume of water was so great that it overtopped and washed away an earthen bank lower down stream. Sixteen persons were drowned.

Lake Gleno dam, in Italy, failed in December, 1923, when six hundred people lost their lives. The dam was 143 feet high and 863 feet long, and poor foundation and construction work were the causes.

Summary of Causes.

To sum up, the following instances of dam failures have been cited by Dr. Herbert Lapworth*: (1) Failure by undermining, due to water-bearing beds below the foundation; there are about a hundred examples of this class in America alone. (2) Failure due to excessive leakage through open joints in the foundations. (3) Failure due to slipping or settlement of earthen embankments on a slippery or soft base. This class includes the Bradfield disaster of 1864, and numerous other instances in India and America.

In addition, failures have occurred owing to (4) insufficient spillway capacity and consequent overtopping. (5) Unequal settlement in the foundation, and (6) superstructure of the dam. (7) The ill-designed connexions of puddle to rock or concrete cut-off walls, and (8) defects in puddle. (9) Dam as a whole slipping on its base. (10) Dam overturning.

* *Transactions* of the Institution of Water Engineers, Vol. XVI.

Economics and Education in America.

By J. A. Benn.

A new view of American economic conditions is suggested in the following notes, which are designed to describe the situation as it exists, rather than to comment upon its political aspects.

More particularly since the war, the United States has been extensively studied by British economists and journalists, as well as by business and trade union delegations. All these visitors have returned impressed by the general wealth and high standard of living, and they have mainly attributed it to machinery and mass production. A more intimate acquaintance with everyday American life does not weaken their conclusion, but it suggests that another and somewhat deeper explanation is to be discovered in the educational system.

Wide Opportunity.

As applied to the United States, Professor Marshall's definition of economics as not only a study of wealth, but on the more important side a part of the study of man himself, must certainly embrace the wide educational opportunities which every citizen enjoys. This influence is unusually marked in a country with few hide-bound conventions, where the population is constantly being recruited by immigration. During the past hundred years more than twenty-five per cent of the increase is attributable to this factor, and the figure had risen to thirty per cent when the restrictive laws of 1917, 1921, and 1924 were introduced. These new citizens enter the country as a break with the past, and begin another chapter in a consciously receptive frame of mind. President Coolidge once expressed such motives in connexion with education, when he said that his country did not wish its system to be based on Greek or Roman traditions but to be "supremely American." As a technical definition this remark is quite nebulous, but it exactly expresses the freedom with which the problem has been approached. An analogy given by Mr. St. Loe Strachey relates how when Roosevelt was convinced of the need for the Panama Canal, he refused to delay by reconsidering the engineering difficulties, but determined to "make the dirt fly" in the shortest possible time. In the same way, the Americans have not greatly troubled about the best type of education in the abstract but have made the dirt of learning fly. "The essential thing is to get the structure up. Later there will be plenty of time to consider how to decorate and furnish it. That, unconsciously if not designedly, has been the attitude."

In a country where State participation in the affairs of the people is comparatively undeveloped—except, paradoxically, in a few absolute measures such as Prohibition—it is unexpected to discover that the taxes provide £300,000,000 annually for elementary and secondary education. Public relief does not officially exist for the poor or unemployed, and insurance and pensions are practically unknown, yet nowhere in the world is free education more liberally provided or more generally regarded as a natural right. The charge of unequal opportunity can seldom be justly made, a fact which by itself confirms the American's belief in personal initiative and subconsciously inspires his attitude to work and to industry.

The British Budget provides £71,000,000 for the education of about 7,000,000 children, compared with the American scale of £300,000,000 for 24,000,000 children. Proportionately, the United States therefore spends twenty per cent more on each child. As these figures concern only those who are educated at the State schools, it will be inferred that larger numbers of American children attend these institutions—a factor which is probably the most fundamental in the social and economic life of the people. If in England it is the exception for those with more than a certain means to send their children to the State-provided schools, in America this condition is largely reversed. A "middle-class" parent seldom sends a boy to boarding school at least until he is fourteen, and after that age it is unusual to do so; he is sent as a matter of course to the local "public" school. Of the 26,000,000 school children in the United States, only 2,000,000 are registered in private schools; the figure for England is much less certain, but it appears to be 1,000,000 out of 8,000,000 children—more than one and a half times the American proportion.

The State Universities.

Another important factor is that the State-schools may be attended up to the age of eighteen, and large numbers can therefore attain university standards. Every American State maintains at least one university, and on an average three, at the public expense, in addition to the private institutions, which number altogether 500. There are more than 500,000

university students, besides some 200,000 attending technical training schools. The English and Scottish universities contain fewer than 50,000. Making allowance for the fact that the American population is two and a half times as large, there are four university students for every one in Britain. The agricultural state of Iowa alone has fifteen universities —as many as there are in England—although its population is but two millions.

Technical Training.

The standards vary considerably, and some are scarcely universities at all according to English requirements. In humorous vein, Sir Arthur Shipley once related an experience in a Western State, where he got into conversation in a railway carriage with a "college president"; but inquiry revealed that the Faculty at present consisted only of this dignitary and his wife, though it was "hoped to add to that number quite shortly"! Sir Arthur also remarked on the curious courses sometimes offered to students, citing the case of a young lady who intended to supplement Greek history and Shakespeare with lessons in pottery and jewellery. The subjects offered, that is to say, include many not taught in English universities. The provision of specific technical training is not so general as is often supposed, but some of the courses would only be found in England at the purely technical school. A writer in an American university journal has affirmed this tendency, in suggesting that "since industry is becoming more technical daily, almost every business is demanding a college training."

I may perhaps remark in parenthesis—lest I give the false impression that the American universities are not mainly concerned with cultural studies—that the new novel of a young graduate of Yale has been described as perhaps the most outstanding achievement in recent literature.*

That mechanical knowledge is second-nature to the American is indicated by the marked development of motor-cars and wireless, and he takes readily to machinery of all kinds. To what extent this faculty is based in education is not easy to determine; it undoubtedly also results from the struggle with prairie and forest, which still persists in some degree and has required all the mechanical aid that could be discovered. The effect of this attitude is at any rate marked in industry, and no American workman regards the tool as his enemy. In amusing contrast was the humiliating experience of an English psychologist, who asked a building labourer why he was pulling his barrow. The other men on the job wheeled theirs in front of them—surely this exception showed some subtle appreciation of mechanical principles. "Why am I *pullin'* it, Sir? Because I'm sick of the sight of the —— thing!"

Barrows in America have long been replaced, and the man who controls the automatic truck is probably himself on the verge of discovering a yet more efficient substitute. He is, of course, in danger of never pausing to ask himself whither he is heading. But whatever the future may hold, his mechanical outlook is certainly providing meanwhile an unsurpassed standard of livelihood, besides maintaining a level of education which is likely itself to yield a satisfactory answer.

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* Thornton Wilder's *The Bridge of San Luis Rey*. In Mr. Arnold Bennett's opinion "the writing has not been surpassed in the present epoch."

Arctic Expeditions.

A new departure in travel is offered this summer by Mr. Bee-Mason, of Burgess Hill, Sussex, who is organizing two Arctic expeditions for the general public. Owing to modern knowledge of diet and conditions the Arctic no longer has the terrors it once presented, and should afford a new holiday field for sportsmen and naturalists, as well as photographers. Mr. Bee-Mason was official kinematographer on the "Quest" with the late Sir Ernest Shackleton, and by an interesting circumstance he has secured the ship for the new expeditions. After a voyage of 2,000 miles to Spitsbergen, to the famous Guillemot Range in the Hinlopen Strait, the journey will be continued round Cape Mohn, and along the great ice wall which extends for over eighty miles. Walrus, seal and polar bear abound, and good sport is expected, including eider-duck and geese. The hundreds of reindeer at Spitsbergen are under the protection of the Norwegian Government, but application has been made for permission to shoot a limited number. Should ice conditions be favourable, the expeditions will make for Franz Joseph Land and will land there for a short time. The return journey will be made round South Cape and thence to Bergen. Each expedition will last six weeks, leaving Newcastle on the 30th June and 9th August respectively.

Unsolved Problems of the Moon.

By J. A. Lloyd, F.R.A.S.

It is still not known why the areas which make up the full moon's "face" are so much darker than the rest of the surface. The "man in the moon" is entirely discredited, but possibly some low form of life may exist.

It is scarcely a matter for wonder that the moon has been peered at through telescopes more often, and to greater advantage, than any other heavenly body. Of all such objects, with the sole exception of meteorites, it is the nearest to the earth, its distance being some 240,000 miles, or about nine times the circumference of the earth. In consequence, more is known about the visible surface of the moon than about many parts of the earth. It has been surveyed and charted with a painstaking precision that almost beggars belief. Of late years, especially since the completion of the giant reflecting telescopes at Mount Wilson, U.S.A., all the resources of photography have been called upon to aid the lunar cartographer in his tedious work. And yet, in spite of all this activity, the moon's surface presents a formidable array of unsolved problems which seem destined to exercise the brains of astronomers for some considerable time to come, if, indeed, they are ever finally settled.

The Origin of Craters.

A very casual glance at the moon through a pair of field-glasses or a small telescope reveals a vast number of circular formations, in some places so massed together as actually to overlap. These are the most characteristic features of the moon, and are popularly termed "craters." They can be counted by thousands, and range in size from vast ramparted plains, more than a hundred miles in diameter, down to tiny pits, so small as to be hardly discernible, even in the most powerful telescopes under ideal conditions. Most of them are distinguished by a central cone or a group of conical peaks. The ring-formations are generally divided into classes or types, mainly according to their size, such as walled plains, mountain-rings, ring-plains, craters, craterlets, crater pits, and crater cones. The nature and origin of these curious structures constitutes the first and most important problem in selenology.

There have been many theories advanced to account for the so-called craters. Some are quite plausible, while others are merely ridiculous. One theory developed during the last century was that the circular crater walls were built up by showers of ejected matter shooting up from a central vent, like a fountain. It is, however, difficult to imagine craters of one hundred miles and over in diameter being formed in this way, even granting that the force of gravity on the moon is only one-sixth of what it is on earth. Some of the smaller craterlets might conceivably have been produced in this way, but certainly not the larger ones.

Another view which has had not a few advocates, holds that the lunar craters are the result of direct impacts by gigantic meteorites falling on to the moon from space. The effect has been produced experimentally by shooting clay balls into soft clay, whereby striking reproductions of the craters of the moon have been obtained, even to the central cone which is such a common feature of the lunar formations. This view has not, however, been favourably received, and the arguments against it are overwhelming. For instance, how is it that the earth is not marked in the same way, since it is just as exposed to the meteoric hail as the moon, as well as being a more massive body? It is true that there is a crater in Arizona which is believed to have been formed by the fall of a huge meteorite, but this unique example is only three-quarters of a mile in diameter, and on the moon would rank as a very insignificant object. It has been urged as an argument against the meteor-fall theory that, in order to produce the crater effect a meteor must strike the moon's surface vertically, and it is well known that meteors strike the earth at all angles. But, in fairness to the theory, it must be stated that the Arizona crater appears to have been formed by a meteor falling at a considerable angle, since most of the meteoric matter is gathered to one side of the crater, and yet the pit is fairly circular.

Volcanic in Character.

Yet again the lunar crater rings have been regarded as the wrecks of burst lava-bubbles; as being due to local whirlpool movements in the semi-molten materials of the moon's crust at an early stage in its history; and as the results of powerful radial explosions within the moon, which heaved up the crust into a circular rampart. But none of these theories is really sound.

The lunar craters look like extinct volcanoes, and volcanic they must certainly be in character: probably they were volcanoes of the type known on earth

as "quiet." There is an excellent example of this class in the island of Hawaii, known as Mauna Loa. Normally this crater is a lake of lava three miles in diameter, with a crust hard enough to walk on. But when in a state of eruption, the floor rises and cracks in all directions, while through the fissures there exudes a sea of molten lava which continues to rise until it overflows the crater walls and pours down the outside. When the disturbance subsides the level of the floor sinks and the crater gradually assumes its normal appearance. Each eruption, however, slightly enlarges the crater and adds to the height of the walls. In much the same way it is probable that the lunar craters were formed in past ages.

Recently another ingenious theory has been worked out, and is regarded by those most competent to judge as being highly probable. It assumes that the expansive gases within the moon would cause the crust to bulge at its weakest points. When the bulge has reached a certain size, depending on the tenacity of the material, it would crack at the summit or crown, the edges falling in, to be melted in the well of molten lava beneath. In this way a circular crater would be built up, continually enlarging in size until the disturbance has spent itself, while it would exhibit walls steep on the inside but gently sloping on the outside, which is exactly what is observed in the lunar ring formations. But which of these theories is the right one will probably never be certainly known.

THE TRIESNECKER CRATER.

Probably the most spectacular cleft-system on the moon. The depth of such clefts may be as much as ten miles.

If we look at the full moon through a good field-glass, or failing that examine a modern photograph of the moon, we shall find that the dominant features are extensive systems of brilliant rays radiating from certain craters. The most remarkable of these ray-systems is that associated with the crater Tycho, from which the streaks extend for enormous distances. These rays are undoubtedly the most mysterious phenomenon to be found on the moon. The most probable explanation of their nature is that they mark the position of radiative cracks formed in the moon's crust by the expansion of sub-surface material, through which cracks some crystalline substance has exuded, and spread over the surface. Another theory is that the bright streaks are deposits of salt left over from the dried-up oceans of the moon.

There are, however, true cracks in the moon's surface which are generally known as "clefts" or "rills." A vast number of these have been discovered by means of large telescopes, and they are among the most delicate features visible on the lunar surface. Probably the most spectacular cleft-system is that near the crater Triesnecker. They form a complex network covering a large area, and evidently have their origin in a small crater which must have marked the seat of the disturbance that gave rise to the cracks. The sides of these clefts are practically perpendicular and their depth must be very great, though, of course, it is impossible to determine how deep they really are. Ten miles is a probable estimate. Some critics deny that the clefts are continuous. They consider them rather as chains of minute crater-pits too close together for the telescope to separate them. Such crater-chains are to be found on the moon, notably near the crater Gopernicus, but the practised observer would never confuse them with true clefts.

The dark areas which to the naked eye make up the "face in the full moon," and which were called "maria" or seas by the earlier astronomers, provide yet another lunar problem of the first magnitude. They are now known not to contain water, and the telescope reveals them as desert plains. It is possible, of course, that they are dry sea-beds, but this is by no means certain. Their roughly circular shapes suggests a common origin with the walled plains and craters of the moon, although their areas would seem at first sight to render such a view untenable. Why are they so much darker than the remainder of the lunar surface? That again, is a problem awaiting solution.

The question is often asked, Is there life on the moon? Or is a "man in the moon" an utter impossibility. The answer must necessarily depend on the conditions that obtain on the moon's surface. Two vitally necessary factors, at least, may be mentioned, in the absence of which life cannot exist, namely, water and air. It is practically certain that

there is no water on the moon at the present time, whatever may have been in the past. The surface of the moon as we see it is a waterless desert, though there are some who hold with Fauth, the celebrated German selenographer, that the whole lunar surface is encased in a thick shell of ice. But though water, or at any rate, water in its liquid state, is absent from the moon, careful observers have reported temporary obscurations of certain regions that could only be regarded as water vapour issuing from cracks in the crust. Others, working with exceptionally fine instruments, have observed traces of snow lurking in the crevices of certain lunar mountains where the sun's rays seldom penetrate.

It was formerly supposed that the moon possessed no atmosphere. This was concluded from the fact that when the moon passes between us and a fixed star, which happens very often, the star vanishes with startling suddenness the instant the moon's limb reaches it. If there were any appreciably dense atmosphere on the moon, it would introduce a refraction effect, causing the star to linger, as it were, on the extreme edge of the moon's disc, before finally disappearing. On the other hand, there are well-authenticated observations which tend to show that the moon does possess an atmosphere of a sort. For instance, it occasionally happens that a planet is occulted by the moon in the same way as a fixed star. In this case a dark band, parallel to the moon's edge, has been observed to cross the planet. However, this dark band may be due to some other cause, as yet unknown, as it seems much too narrow to be an effect of a possible lunar atmosphere. Then again, a prolongation of the cusps of the new moon beyond the terminator has often been observed, and this is generally regarded as a twilight effect due to an atmosphere. However that may be, what air there is on the moon must be of an extremely tenuous nature, not at all like our atmosphere.

SURFACE OF THE FULL MOON.
View showing bright radiating streaks and dark plains which present a problem of the first magnitude.

The dense atmosphere round the earth acts as a very efficient screen from the fierce glare and heat of the sun. It also acts as a blanket, preventing the heat received from the sun during the day from being dissipated away into space during the night. On the moon, matters are very different. During the lunar day of a fortnight's duration, the surface is exposed to the unmitigated light and heat of the sun, whose rays beat down on it with a merciless intensity quite unknown on earth. In these conditions the temperature of the lunar surface rises until it becomes at least as hot as boiling water. Then, during the lunar night, for a further period of fourteen days, it is exposed to the terrible colds of outer space, compared to which our Arctic regions would be regarded as mild. With these facts in mind, it is a waste of time to discuss whether there are any men on the moon. The moon is, to all intents and purposes, a dead world.

Are there any changes going on in the moon at the present time? It can be answered at once that there are, though they are by no means obvious to a casual observer. It is true that Sir William Herschel believed that he had witnessed a volcanic eruption on the moon, but it is now known that he must have been mistaken or deceived in some way. Nothing so spectacular has ever been seen since.

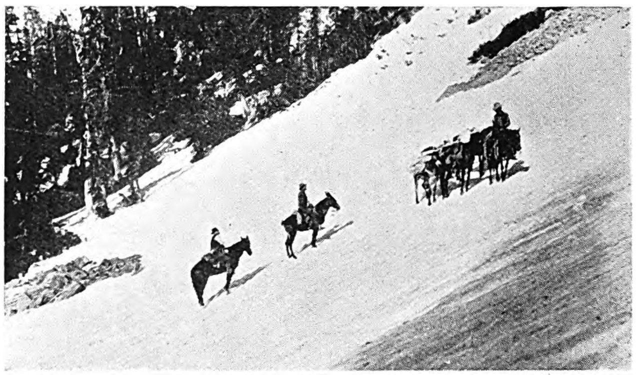
A small crater in the Mare Serenitatis, named Linné, appears to have undergone a distinct change since the last century. It was described by Beer and Madler as deep, and was about six and a half miles in diameter. However, in 1866, Schmidt, of Athens, noticed that the crater had disappeared, while its place was occupied by a whitish patch, as if the walls of the crater had collapsed. This seems to be the best-attested case of actual physical change on the moon.

Those who have devoted years of patient and assiduous study to the surface report that there are certain regions which undergo periodic changes of colour as the lunar day advances—seasonal changes, in fact, which seem to point to some kind of vegetation growing there. While there may not be men in the moon, or life in any of its higher forms, the idea is gaining ground that some low form of life, such as moss or lichen, may cling desperately to its rocky face, and that the moon is not entirely the bleak and arid desert it was formerly believed to be.

The Geological Survey of Alaska.

Under U.S. government auspices a geological survey is being continued in Alaska, where two-thirds of the ground has still to be adequately charted. A correspondent here reviews the work in this territory.

In England the term "surveyor" is generally associated with housing, but in such countries as the United States and Canada, one of the most important branches of the science is geological or mineral surveying. The work is wide and full of adventure, and in carrying out exhaustive surveys months are sometimes spent by expedition parties.



A SURVEY PARTY "ON THE TRAIL."

Under the auspices of the U.S. Government, wide areas are still being explored by the geologist, and during recent years discoveries in the mineral industries, notably in connexion with petroleum, have had noticeable effects on geological work in America. The most conspicuous result has been a great increase in the number of geologists professionally engaged on oil and mining problems.

The United States has, of course, reached that point in the utilization of many of its mineral supplies where the easily discovered deposits are known and are under development. Though the commercial world realizes the situation but dimly, the peak of production in some of the essential necessities of civilized life may have already been passed, and the technical staffs of the mineral industries are well aware that the task of finding reserves is becoming more difficult. This need has stimulated the demand for helpful information, and the aid of the geologist is increasingly sought. Further, there is a growing recognition of the value of pure research, which may throw light on the laws controlling the occurrence of the useful minerals. The geologist in commercial work is usually so busily engaged in applying known principles that he has little opportunity to develop new ones. The research institutions having geological staffs are, under these conditions, more and more expected to supply the basic data needed in the development of mineral resources. The details of small areas can often be adequately determined by the practising mining engineer, but accurate geological maps are required of larger districts and stratigraphical determinations must be made, with details of structure, paleontology, the extent of mineralization, and so forth.

For some considerable time extensive exploration work has been in progress in Alaska, to determine the degree of probability that in Arctic Alaska may be found sufficient petroleum to meet naval and other needs. After more than a quarter of a century, however, the Geological Survey has covered adequately only about a third of the territory with standard maps and reports. Of the remaining 350,000 square miles, nearly 200,000 will be surveyed as soon as funds and personnel are available. South-eastern Alaska, in addition to containing minerals of commercial value, has water-power resources that will aid in developing the mineral and forest product industries. Other important areas are those in the general vicinity of the Canadian Pacific Railway, and a belt of mountain area from 100 to 300 miles wide, stretching from the international boundary to the Arctic Ocean on the west, which is largely unsurveyed and in which there are indications of valuable mineral deposits. Larger problems relating to the different mineral resources of the territory must also be studied, but the accumulation of data has now reached a stage where the compilation of a general geological map of Alaska is warranted.

The past history of Alaska is an adventurous one. About thirty years ago Alaska was almost unknown, except to the pioneers and prospectors who had fished its teeming coasts, trapped its furs, and started small towns. With its neighbour, the Yukon, it was otherwise hardly more than a geographical curiosity—a huge unexplored block of land over three-quarters of a million square miles in size, forming the northern tip of the American continent. As far as could then be estimated, it had no very remarkable

THE ALASKA SURVEY: PACK HORSES ARE USED TO CARRY THE VARIOUS INSTRUMENTS.

resources or trading possibilities; on the contrary, it was apparently a land of perpetual winter, in many ways resembling Russia, to which it had once belonged and from which, at the Bering Strait, it was so narrowly separated. In 1896, however, the discovery of vast quantities of gold in the Klondike let loose so much sensation that overnight Alaska became the most talked-of place on earth. That feverish stampede to the north was like nothing that had ever happened before, or is likely to happen again.

Alaska is still a land of romance, its atmosphere impregnated with memories of those sad, glad days when the century was just turning over, but gold has ceased to be its principal advantage. It proved, indeed, a false hope in those many ghost-like "cities" that parade their empty shells from Dyea to Nome—but there is equally the romance of to-morrow, the discovery of other and richer resources, the development of a vigorous, prosperous, northern empire. Alaska is certainly a land of contrasts, and it is mistaken to regard it as always under winter. In summer, gorgeous vivid flower gardens are everywhere seen, for the warm Japan current which strikes Vancouver Island is deflected northward, and carries to the "Land of the Midnight Sun" the same delightful humidity that the Pacific Coast knows. And it is a land of magnificent scenery.

Geographically, Alaska can be divided roughly into three parts. First, there is the "Pandhandle"—a long, narrow ledge of land between the British Columbia boundary and the sea, running from latitude 55° to 60°, and bold, steep and craggy. Secondly, there is the huge blunt peninsula of "continental" Alaska, running from latitude 60° to 300 miles north of the Arctic circle, and measuring some 600 miles from the Yukon boundary, west to Bering Strait; and lastly, there is the long, broken fringe of the Aleutian islands.

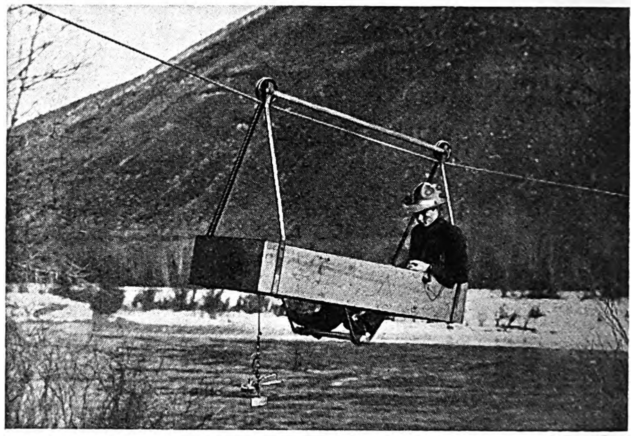
The Yukon territory can be easily confused with continental Alaska, for its topography, atmosphere, and general environment are similar; but it is separate politically, being a part of Canada and not of the United States. It lies between Alaska and the North-west Territories, and extends from the northern boundary of British Columbia to the Arctic Ocean. Alaska has an area of 591,000 square miles, and a population of about 60,000. Its territorial capital is

MAP-MAKING UNDER DIFFICULTIES.
The tripod is tied with ropes to keep it stationery while the surveyor is at work.

Juneau. The Yukon has an area of 207,000 square miles, with a population of 5,000 and territorial capital at Dawson.

The mountains that fringe the Inside Passage to Alaska form practically one range—the Coast Range. Leaving Vancouver, the mountains are, as a rule, higher on the mainland side than on Vancouver Island, averaging 3,000 to 4,000 feet in height; but towards Queen Charlotte Sound they tail off somewhat. From the other side of the Skeena River, and entering the long Alaskan "Panhandle," the altitude increases again. From Juneau north to the White Pass the range is sometimes known as the Chillkoot Range. In the extreme south-west of the international territory, where it tucks into Alaska, and lying on both sides of the international boundary, is an isolated, exceedingly lofty group of mountains known as the St. Elias Range. Mount Logan (19,539 feet) and Mount St. Elias (18,024 feet) are the highest peaks, of which the former was climbed for the first time in 1925. They are, however, very inaccessible owing to lack of transport. Mount McKinley, the highest mountain on the American continent, lies in the National Park of that name about 400 miles west of this group.

That the duties of the ground surveyor in this territory are certainly adventurous is borne out by the accompanying photographs issued by the U.S. Department of Interior. An expedition party for a geological survey such as that in Alaska, consists of a chief geologist, ten assistant geologists, four topographical engineers and assistant, a draughtsman and three clerks. At selected gauging stations the volume of water carried by the streams is measured and records of stage and other data are collected, from which the daily stream is computed. The information thus obtained is sent from the district offices to Washington, where it is prepared for publication. In this way the records from different parts of the country are made uniform, and standardization is further effected through annual conferences of the engineers.



MEASURING A RIVER'S CURRENT.
Where no bridges are available, a cable railway is slung across the river. The measuring instrument is seen hanging from the trolley, before being lowered.

Photographic Congress.

THE seventh International Congress of Photography, to be held in London from 8th to 14th July under the auspices of the Royal Photographic Society and the Commission Permanente des Congrès Internationaux de Photographie, will provide an unusually complete resumé of new developments in this science. Apart from discussions on standardization, in particular relating to kinematography and plate-testing methods considered at the previous congress in Paris, in 1925, there will be papers on foreign researches, presented through official national channels. As on former occasions, the Congress will consist of three sections, dealing with scientific and technical questions, pictorial photography and the bibliography of photography—including copyright, patents and other legal problems. In the last connexion, it is proposed to hold exhibitions of pictorial and record photography, and of historical apparatus, while there will be excursions to places of interest. Professor Sir William Pope is chairman of the executive committee of the Congress, for which application for membership (half a guinea; with copy of Proceedings, one guinea) may be made to the honorary treasurer, at 35 Russell Square, W.C.1. A full programme of arrangements will be sent to members before the opening date, and it is hoped to issue in advance, abstracts of the papers to be presented at the meetings. For the convenience of foreign members it is hoped that these will be available in French, and if possible in German. The scientific applications of photography to be discussed include spectroscopy and photomicrography, as well as astronomical, natural history, and aerial work.

"CAT'S CRADLES."

To the Editor of DISCOVERY.

SIR,

I regret to find that an error occurred in the description of the Fijian string game called *Balawa*, given in my article on "Cat's Cradles" in your April number. In the fourth stage of construction, instead of dropping the thumb and little finger loops of the *left* hand, the corresponding loops on the *right* hand are those to be released.

Without this correction the desired figure cannot be reached.

Yours sincerely,

Freetown, Sierra Leone. JAMES HORNELL.

Benn's Sixpenny Library.

The following concludes Mr. V. E. Pullin's review of the first scientific titles in this new library.

The next sub-branch of the series is concerned with science of living rather than non-living matter. The first book on our list is Dr. William J. Dakin's *Introduction to Biology*. Physiology is of necessity of the greatest interest to all of us. When it fails to interest we die. Important though it is, it is lamentable that so few people know anything at all of the working of their own bodies. The body is a highly complex and most interesting engine. Dr. Dakin explains the working of this engine from the very beginning. "Fundamentals" he calls it. He describes the structure and nutrition of that important individual, the protoplasmic cell. In his discussion on nutrition he refers, in a way that is sure to excite interest, to those important substances—now so much advertised—vitamins. There is another unit concerned in biological life which has also received some measure of popular notice, although not always very accurately described or understood. I refer to hormones. This entity, which exerts such enormous importance in reproductive activity, is discussed in an interesting manner, and its significance is properly explained. The phenomena of reproduction, growth and death are traced from the simplest organism to the most highly differentiated individuals. As an introduction to the vital subject of physiology it is difficult to imagine anything better than this book.

From biology it is but a short step to Dr. Ronald Macfie's book on *The Body*. Here human physiology is explained at quite considerable length. A lot of space is devoted to the nervous system and the functioning of the brain. Physiology is not by any means an easy subject for the layman, but Dr. Macfie has so interpreted his subject that it will be found full of the greatest interest to the general reader.

Evolution.

Professor MacBride's *Evolution* is concerned with a much more popular subject. Popular Darwinism is by no means always true Darwinism. The real meaning of, and evidence for, evolution is set out in this book with commendable clarity, and it should go far to engender a right conception of this important subject where perhaps much misapprehension existed hitherto.

The next book in the series is *The Mind and its Workings*, by Mr. C. E. M. Joad. Psychology is another frequently misunderstood word. It is sometimes associated with various kinds of occult phenomena, whereas really within certain limits it is a highly defined science. Mr. Joad's book is philosophical in design, and in execution it is moderate and well balanced. Such interesting subjects as the nature of memory and the nature of the mind are discussed in a most readable manner. The conflicting views of modern psychologists on these subjects are treated with conspicuous fairness. There is no doubt that the branch of science which seeks to explain mind activity has an irresistible fascination, and many readers will be surprised to learn how much has been done in this direction.

Psycho-Analysis.

Psycho-Analysis, by Dr. Ernest Jones—it is interesting to read an authoritative account of this subject. The limits of the usefulness of this branch of science as a therapeutic agent is not very generally understood, and our gratitude is due to Dr. Jones for the way in which he defines it. We may agree or disagree with the principles involved in this system of thought, but we cannot fail to be interested to learn exactly what is aimed at by its professors. The dominating influence of sex in all human activity may be true, but it is somewhat alarming to accept such a doctrine unless it is taught and exercised by suitably qualified practitioners. It is for this reason chiefly that we are indebted to Dr. Jones for his clear and eminently scientific method of handling this difficult question.

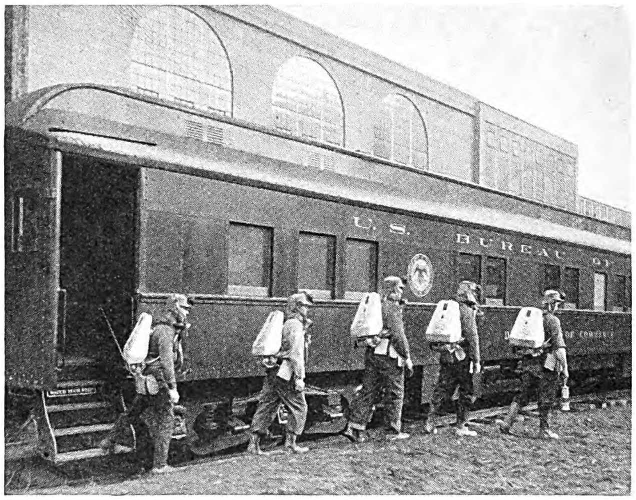
The last scientific book that we have to mention is *The Weather*, by Dr. C. E. P. Brooks. We commend this book particularly to all farmers and professors of agriculture. It is a subject that is notoriously difficult, but after reading Dr. Brooks' book the reader may be in a position to criticize the daily weather forecast, as he will certainly have a very sound knowledge of the principles upon which such forecasts are calculated.

There is very little more to be said concerning this admirable series of books. It would be an excellent thing if they found their way into every school in the country. The subjects dealt with are, as we have already said, presented in a palatable form, and for this reason they may serve to direct the attention of the young generation to matters that may very well influence the whole of their lives. Although the series is generally excellent, it is, of course, true that some of the books stand out in a class by themselves. Nevertheless, we have been so favourably impressed that it has been necessary to write this account with considerable restraint lest our enthusiasm should be too evident.

An International Rescue in a Mines Disaster.

How an American rescue train was sent to the aid of a disaster in the biggest Canadian gold mine, beating all speed records over a thousand miles journey, is a new episode in mining history that has more the character of cinema fiction. Latest discoveries in rescue apparatus were employed.*

UNIQUE in the annals of international humanitarian activities, was the recent dispatch of a United States " rescue car " and crew to help with a disastrous fire in the great Hollinger gold mine, at Timmins, Ontario. Responding to telegraphic messages received late on 10th February, a Bureau of Mines rescue car set out the same night from a remote Pennsylvania coal-mining town, and in the early morning of 12th February it arrived at the Hollinger mine, hundreds of miles north of the Canadian border. Running with special engines provided for every section of its long journey, the car was hurtled through in some hours less than is required for the fastest express trains.



THE CAR THAT MADE THE DASH TO CANADA.
No. 3 of the U.S. Bureau of Mines' fleet of ten rescue cars is the most fully equipped in the world. Kitchen and living accommodation are provided.

The first appeal received from the burning mine was hardly definite enough to enable the Bureau of Mines in Washington to determine the nature and seriousness of the emergency. It was the first time that another country had asked the Bureau for aid of this kind, and the question immediately arose as to the legality of sending the men and equipment out of the country. There was also the matter of expenditure, with little or no precedent or authorization, and it was not known whether the extent of the disaster justified an international expedition. Then the ten rescue cars of the Bureau are at all times widely scattered, being generally engaged in educational work in the remote mining regions, where rail and telegraph facilities are strictly limited. The primary purpose of the Bureau's organization is not, as sometimes imagined, the succouring of life in times of disaster, but is to give instruction in first-aid, rescue training, and accident prevention among the million miners of America. In consequence, the cars are not held at strategic railway points in instant readiness to proceed to the scene of a mine disaster. Further messages from Montreal, however, revealed the serious nature of the Hollinger fire, and sanction was at once granted by the Department of Commerce, of which the Bureau of Mines forms a part.

In the meantime, it had to be decided which of the ten widely scattered rescue cars was the most suitable for this unusual service, a problem involving serious consideration. Fighting mine fires is highly specialized work, the procedure in combatting a metal-mine fire, for instance, being quite different from that required for fighting a coal mine fire. Car " No. 3," which was at Jenners, Pennsylvania, a small coal-mining town some seventy-five miles south of Pittsburgh, was eventually selected. Not only is this the Bureau's " crack " mine-rescue car, having only recently been built and embodying the latest equipment, but it happened to be situated comparatively near to the Pittsburgh experiment station, where ample supplies of fire apparatus were available.

The next task was to get the car moving northward. Jenners is not on the main line of a great railway, and country telephone facilities after nightfall are not those of a metropolis. Several long-distance calls and various telegraphic messages sent from Washington and from Pittsburgh failed to elicit any response. As the hours wore on, the situation looked bad, when by a fortunate coincidence the foreman-miner in charge of the car happened to telephone from elsewhere to the Pittsburgh station, in regard to routine matters. The urgent message was thus delivered. It was not

* Here abstracted from the U.S. Bureau of Mines report, and illustrated with photographs specially sent to *Discovery* from Washington.

easy at midnight to get an engine for the mine-rescue car, at the moment reposing on a little-used side-line in the Appalachian hills, but soon the special train was rumbling down towards the junction of Somerset, some twelve miles away. Next the car was switched to another short line for a run of nine miles, and eventually to the main line, where it was attached to a passenger train going to Pittsburgh. Here it was manned by an expert staff under Mr. Daniel Harrington, chief engineer of the Safety Division, and extra equipment was hastily loaded.

Fifteen sets of oxygen-breathing apparatus were carried, with gas masks, and carbon monoxide "self-rescuers." In addition to flame safety lamps there were also electric flash-lights and cap-lamps; ten cylinders of oxygen; four canaries; chemical detectors for carbon monoxide; and gas-analysis apparatus. Each set of breathing apparatus is capable of supplying the wearer with oxygen for at least two hours in any smoke or gaseous atmosphere. The little self-rescuers, worn suspended from the belt, will filter poisonous fumes from air and are exceedingly useful in emergency. The gas masks are considered to give protection against more deadly gases than any other type of mask, but do not provide oxygen—hence they cannot be worn, like the breathing apparatus, in atmospheres deficient in oxygen. The carbon monoxide detectors are ingenious devices which warn of the presence of this gas through change in colour of iodine pentoxide. The gas-analysis apparatus enables the observer to determine from an air sample whether fire may be raging in a particular area of the mine or whether poisonous carbon monoxide or inflammable methane is prevalent. Each oxygen cylinder contained ten cubic feet of oxygen under approximately 2,000 pounds pressure.

In addition to mine-safety equipment, Car No. 3 is provided with numerous devices, such as electric charging apparatus for use with the cap-lamps. There are also complete electric light and water systems; an oxygen pump and electrical refrigerator; besides a demonstration room, a bathroom, and dining and kitchen arrangements. Beneath the car are specially constructed compartments for the storage of stretchers, oxygen cylinders, and other equipment.

MINE EXPLORING AFTER A DISASTER.
The oxygen apparatus carried on the back provides two hours breathing supply. Other devices seen include carbon monoxide detectors and electric cap-lamps.

At 9.14 on the morning of 11th February, the car was headed northward for Buffalo, over the Pennsylvania Co.'s line from Pittsburgh. American and Canadian railway authorities co-operated in the emergency, and a clear right-of-way was provided, which allowed the train to reach Buffalo at 3 p.m. Not many minutes later it was heading over the Canadian National line for Toronto, and at 6.20 a.m. on 12th February it drew up at Timmins, 485 miles north of Toronto. All previous time records had been beaten. It was the fastest time ever made between Pittsburgh and Buffalo, being two hours less than the best passenger schedule, while an average speed of 47 miles an hour was maintained for the 1,000 mile run. Speeds of 70 miles an hour and more were attained, although long stretches of track on the northern part of the run consisted of snake-like curves, and four feet of snow lay packed through the northern forests. Telegraphic messages to Buffalo, Toronto, and other junction points had provided special engines in instant readiness. At the international boundary, custom inspection was waived, and everyone throughout accelerated the long northward flight of the train. The engine driver over the last northern division stuck valiantly to his post, although nearly frozen when the special train was at last brought to a standstill.

Arrived at their destination, the American volunteers did not immediately don their apparatus and descend into the burning gold mine, as modern mine fires require other methods. Unlike a burning building, on which high-pressure hoses are immediately applied, a fire in a mine involves knowledge of the lay-out of its devious passages. There were nearly 100 miles of underground workings in the Hollinger gold mine, and nothing was to be gained by a headlong plunge into its smoking depths. The efforts of the mine staff aided by volunteers had already rescued thirteen of the entombed men at the outbreak of the fire, but

lack of oxygen-breathing apparatus, such as was carried by the Bureau car, had prevented a more thorough exploration of the mine. There was scant hope that any of the other missing men would be found alive.

At 8 o'clock on Sunday morning the American engineers went underground. The passages of the smouldering mine were filled near the fire with volumes of smoke, and while with their oxygen apparatus the men could penetrate this dense atmosphere, they were practically helpless to do more than grope their way round. The problem therefore admitted of but one solution—to clear the mine atmosphere in the shortest possible time. To this end, a method long used successfully in coal mine fires was brought into play, namely, regulation of the air currents by means of canvas screens placed at strategic points. Air compressors forced the pure surface atmosphere into every crevice of the underground passages, displacing the smoke, and for hours the rescue men advanced towards the smouldering fire area, their general objective. Special consideration had also to be given to the powder magazine, situated barely 300 feet from the fire centre. This last was reached after ten hours work, and streams of water from 1,200 feet of hose were then directed on the fire. By midnight, in places where it had been impossible to see objects a foot or so away, the bodies of forty unfortunate victims were being removed in fresh air, but fire work had to be carried on continuously until early on Tuesday before it was completed.

On the return journey, made leisurely by passenger train, the American rescue party had a rousing send-off, and at Toronto their car was visited by more than 2,000 people, including members of the Canadian Institute of Mining and Metallurgy. A reception was held later in the Ontario Parliament Building, where the Premier, Mr. Howard Ferguson, expressed Canada's gratefulness for the help that had been extended by her neighbour to the south. "I hope," the Ontario Minister of Mines afterwards wrote, "that cordial relations may long exist as a bond between your people and ours, and between the mining fraternity of the United States and Canada."

Book Reviews.

POPULAR PSYCHOLOGY.

The Mastery of Mind. By J. C. Flower. (Lutterworth. 5*s*.).
That Mind of Yours. By D. B. Leary. (Lippincott. 6*s*.).
Making up One's Mind. By W. Roberts. (Daniel. 2*s*.).

There used to be a branch of philosophy called ethics; its object was to define the meaning of the terms right and wrong, and to indicate the nature of the good life. It was even claimed by some that it helped one to live the good life. Then came psychology; at first rather an arid and technical affair, which compiled lists of instincts as if they were glands, it seemed to have no relation to life as we knew it. Presently, however, under the influence of psycho-analysis it began to concern itself with practical problems, and to lay down rules for successful living. In this guise it is called "the new psychology," and, as morality becomes increasingly unfashionable, so that to be called virtuous is almost a term of reproach, it is coming more and more to supersede the old-fashioned ethics.

The three books mentioned at the head of this review are cases in point. They are concerned not only to explain psychology, but to explain it to the advantage of the reader; they propose, in other words, to make him better, or rather they encourage him to utilize psychology in order to make himself better. These books, then, are in every sense of the word popular. Mr. Flower's is written in dialogue form, while in Mr. Roberts' a breezy psychologist discourses on a variety of objects such as chairs, wild cats, and the soul, to an entranced family circle. His object is, it appears, to enable one to avoid vacillation and to arrive rapidly at firm decisions by explaining what the mind is and what making it up involves.

The object of Mr. Flower's book is more general, but no less laudable. It is to help us to master our mental processes, and so to become more effective as human beings. In order to achieve mastery it is necessary to know what one proposes to master, hence the importance of psychology. Mr. Leary has observed that thinking is not enough to make us happy. On the contrary, the happiest organisms, for example, cabbages or pigs, are probably those that think the least, while among so-called thinking beings, the intellectual, as everybody knows, is morbid and exacting, given to making impossible demands of life and irritating his friends. Hence, while thinking should not be abandoned, we must, according to Mr. Leary, insist on obtaining the right material to do our thinking with, the right material being apparently not an isolated figment called the reason but "the emotions, the physical condition, the daily behaviour, and all those other aspects of human beings which modern psychology at last has come to emphasize." The organism, that is to say, is a unity or ought to be; it is as a unity that it should do its thinking, and it is the business of psychology to tell it how to become one.

Now I do not wish to criticize these books on technical grounds—Mr. Flower's, as a matter of fact, is exceedingly good, his discussion of the will, for instance, being at once more intelligent and intelligible than the reader is likely to find in more imposing works on psychology—but I do feel sceptical about the existence of these alleged practical benefits of studying psychology, which all three writers seem to expect. There are two things in particular I should like to say about them.

First, is it in fact true that an acquaintance with the so-called practical implications of the new psychology helps us in the business of living? If we are abnormal or eccentric, no doubt it is; but even then we were better with a trained psycho-analyst than trying to cultivate will power or adjustment by ourselves. For the rest, one may well ask whether psychologists are them-

selves particularly noticeable for efficiency in practical affairs and mastery of the art of living. I think it is clear that they are not. They are not more successful as husbands or as citizens than their neighbours; they are just as likely to lose their tempers when they break a bootlace or to swear when they miss a train. Yet it is to be presumed that they have mastered all the hints on living that the new psychology, as expounded by them, has to offer.

In the second place, the new psychology is something of a hypocrite. It sets out to examine and to describe in an impartial and scientific spirit the working of the human personality. It is not interested in moral problems, and duty is for it a *démodé* word. Its concern is not with what ought to be but with what is. "To look at human beings psychologically," says Mr. Leary, "is to look at them without pride or prejudice; it is," he continues optimistically, "to look at them as they are." But having kicked ethics ostentatiously down the front steps, it proceeds to introduce them surreptitiously through the back door. I say surreptitiously because while, as we have seen, making use of old-fashioned ethical notions such as that of betterment, it uses new words to describe them, words which have a pseudo-scientific flavour. It does not use the word virtuous, it substitutes "properly intergrated"; it does not say "a good character" but a "personality well adjusted to its environment." And sometimes we come across a phrase which fairly gives the game away. "Psychology aims at such knowledge of human nature that it can mould, change, *better* that human nature," says Mr. Leary. Now what does "better" mean? More adjusted to environment, perhaps. But what is the good of being adjusted to your environment, unless something of value comes of it, and something of value reintroduces the nature of "good"?

I conclude that if we are to deal in "goods" and embark in moral exhortation, then we had better make a clean breast of it and have recourse to ethics or religion; psychology should keep to its task of analysis and description, and not offer itself as a substitute for either. Yet this is what the new psychology too often seems to do.

C. E. M. JOAD.

PREHISTORIC CULTURE.

The Age of the Gods. By CHRISTOPHER DAWSON. (John Murray. 18*s*.).

Although anthropology, like other sciences, is being more and more sub-divided among specialists, in one branch, namely, archaeology, the view has broadened. In details it is still and always will be a highly specialized study; but the student who seeks to interpret the detail, and to trace the growth of culture in its broader outline, can no longer expect to rely solely upon the data of the archaeologist in the narrower sense, or even upon the comparisons with primitive material culture with which a previous generation was content.

It is inevitable that Mr. Dawson's book should suggest some such reflexion, for it is an attempt to reconstruct the origin and growth of cultures in prehistoric Europe and Western Asia from the beginnings down to the Iron Age broadly in the light of anthropology and ethnology, to reconstitute the religious beliefs and the social organization at different stages in the light of social anthropology, of the comparative study of religion and of survivals in folklore. Probably most readers will already be familiar with the interpretation of palaeolithic cave paintings by primitive conceptions of sympathetic magic. They will perhaps be less familiar with the evidence to be deduced from animal worship and totemism and the conception of the Mother Goddess, of which the beginnings are to be seen in the statuettes of palaeolithic man but find a wider extension with the expansion of the fertility cult in the agricultural Neolithic Age. It is, however, in dealing with Mesopotamia and its city states and with early Egypt that Mr. Dawson's method of treatment is most illuminating. The relation of Irish legend to the impact of Iberian culture on Ireland, gives rise to some remarkable correspondences such as that of the coming of the children of Miled from Asia Minor by way of Crete to Spain, and thence to Ireland, with the period of expansion of the megalithic culture. But, as the author notes, they must be accepted with caution, in view of the way in which geographical terms in popular folklore have obviously been "worked over" in the hazy light of the fragments of monkish knowledge which filtered through to the people.

Taken as a whole, Mr. Dawson's book makes an admirable guide to that background of knowledge of the growth and character of prehistoric and early historic culture which are an essential to perspective in the application of archaeological discovery.

E. N. FALLAIZE.

MICROSCOPIC ANIMALS.

Hunting under the Microscope. By SIR ARTHUR E. SHIPLEY, G.B.E., F.R.S. Edited by C. F. A. PANTIN, M.A., Physiologist to the Marine Biological Station, Plymouth. (Ernest Benn Ltd. 8*s*. 6*d*.).

As a preliminary note in *Discovery* (February) has indicated, this delightful little book consists of a series of essays by the late Master of Christ's College, first published in its columns and now collected and arranged by one of his most brilliant pupils Mr. C. F. Pantin, who also contributes a valuable introduction.

The object of the book is to interest the average amateur in the creatures of microscopic size which he is likely to meet with in examining the water from fresh-water pools, gutters, and ponds. But the insight and genius of the author are displayed in the way in which he makes each object illustrate an important point in biological science. Thus the very first chapter on "Suspended animation" raises the fundamental question "What is Life?" "Life," says Sir Arthur, "is difficult if not impossible to define, but living beings have certain definite attributes, such as breathing, feeding, moving, and so on." Yet, strange to say, all these attributes can cease and yet life may persist as a potentiality, as is shown by small creatures such as the Tardigrada (Bear-animalcules) and Rotifers (Wheel-animalcules), which can dry up and become motionless and almost indistinguishable from particles of dust, and yet revive and become active when moistened with water.

The same power in lesser degree is exhibited by frogs, which bury themselves beneath stones in winter, by reptiles and even by mammals such as the dormouse and the racoon, which retire to holes during the winter and enter on a month-long sleep. Nay, as Sir Arthur hints, this power may not be wanting to the human race itself, and he recounts the thrilling story of a Fakir who allowed himself to be buried alive, and who when dug up and examined exhibited no trace of breathing or of heart beat, and yet who was completely revived in a few minutes. Life cannot be defined because to define is to compare, and

there is nothing like it with which we could compare it. Life works through and uses—in a word "regulates"—ordinary matter and energy, but what "it" itself is remains a mystery. In dealing with the green pond-flagellate Euglena, the author discusses the problem "What is the difference between a plant and an animal?" Euglena is green and uses sunlight to split up carbon dioxide like a plant, but it moves like an animal, and has even got a tiny gullet through which it can take occasional meals of solid food. Is Euglena an animal trying to become a plant or a plant trying to become an animal? Sir Arthur Shipley concludes that it is an organism which has not yet made up its mind as to which it intends to be, and that in the Flagellata we reach the seed bed from which both animals and plants have sprung.

In the Slipper-animalcule (Paramecium) we can observe a process of "conjugation" which seems to be the simplest form of sexual union; the author unmasks the real meaning of sex when he points out that such a union between two individuals coming from two different strains is absolutely necessary to maintain the vitality of a culture of Paramecium. The excellences of one strain compensate for the defects of another. In the case of the green sphere Volvox, which is made up of a number of flagellata joined together by protoplasmic cords, the first beginning of definite male and female reproductive cells can be seen.

Enough has been said to show how Sir Arthur Shipley "points a moral and adorns the tale" with reference to each of the minute creatures which he describes. We have no desire to "spoil" the book for its readers by giving away too many of its good things in a review. But the concluding essay differs from all the rest in being biographical; it is an account of the autobiography of Sir Ronald Ross, K.C.B., F.R.S. (whom God preserve!), the discoverer of the parasite of malaria. In this account Sir Arthur Shipley stresses the enormous importance of Ross's discovery for mankind—the long toil which was necessary to accomplish this end, and the official inertia against which Ross had to battle, and the small reward which he received for his labours. Malaria, which formerly made the tropics a white man's graveyard, became capable of control, and it was possible in certain areas to eliminate it altogether. Amongst natives of India too slothful or ignorant to exercise that control it still remains the greatest menace to human life. When the reward meted out to the scientific discoverer is compared with that bestowed on a successful general, or on a very moderately successful statesman on his retirement, it is obvious that mankind has still a considerable distance to go in adjudging the merits of its benefactors.

E. W. MacBride.

MIND AND COLOUR.

Coloured Thinking, and other Studies in Science and Literature. By Professor D. F. Fraser-Harris, M.D., D.Sc. (Routledge. 5*s*.).

This is a collection of interesting papers on various subjects. Though written in a "popular" manner, they are full of thought, often original, and always tersely and pointedly expressed,

The essay which gives its name to the book treats of the curious phenomenon named psychochromaesthia, *i.e.*, the association, in many people's minds, of concepts with colours. For instance, the days of the week may be thought of as differently coloured—say, Tuesdays always green—these coloured concepts being named "psychochromes." The author rightly distinguishes between these and synthaesia or coupled sensations, whose commonest form is a mental image of a colour, produced by hearing music, and changing either with the note or with the key, or else with the voice or instrument. Professor Fraser-Harris says there is "method in this madness," but the "sound-photisms" mentioned by him appear somewhat chaotic.

There seems, however, reason to believe that "coloured hearing" most often connects colours and sounds with regard to their respective wave-lengths. Thus, to many—Raff and Monsieur Lavignac (I quote from Mr. Klein's book "Colour-Music") may be cited as examples—the flute's notes, necessarily high-pitched, recall the colour blue; the oboe's (slightly lower) green; and brass instruments red. Locke's blind man, who called the trumpet's notes scarlet, was surely a typical case of synaesthesia, though Professor Fraser-Harris quotes his thought as a "psychochrome." Dr. Stelzner's case (also quoted), in which speech appeared coloured, and whispering—usually a monotone—non-chromatic, is likewise of great interest as a light-and-sound analogy. But, in the case of many "photisms," such as Baudelaire's, who said that musk-odour reminded him of scarlet and gold—surely owing to the flower's colour—and also of most psychochromes, M. Peillaube's suggestion is probably correct, namely, that they are cases of two sensations with an intermediate subconscious link.

One central idea, the correlation of science with other intellectual, ethical, and emotional activities, runs through most of the other studies in this admirable book.

Mary Barne.

PIKE FISHING.

The Pike Fisher. By Edward Spence, K.C. (A. C. Black. 6*s*.).

Reviewed by Sir George Aston.

"Why go a-fishing? When I tell my friends that I put back into the water almost every pike caught by me, the ladies, and most of the men, say, 'How silly,' and 'why do you go fishing?' and to this the humble and decided answer is that I go fishing not for pike but for pleasure." So writes Mr. Edward Spence in "The Pike Fisher." We can put his view alongside that of Lord Grey of Fallodon, when, in addressing the Harvard Union, he said, "If you don't like fishing, don't fish," and added thereto that if his hearers were to be on a parallel with himself they must find some recreation in which they found as much pleasure as he found in fishing, especially with the fly for trout and salmon.

Mr. Spence has done a good service to anglers in describing to them a sport that can be enjoyed all the year round, without the limitations of season (and cost) that attaches to the pursuit of what used to be called "game" fish. Why pike have never been included in that category no one who has fished for them with tackle of the same strength, in relation to weight, that one uses for trout and same, is able to understand, "What can be expected from a fish dragged by a weaver's beam connected with big hooks swallowed down to its stomach!"

Although the author maintains that he fishes for pleasure and not for pike, he confesses that he fishes for them (the pike) carefully and thoughtfully, and that he has caught a large number of them. Like all books that are written by past masters of the subjects with which they deal, this one on pike fishing makes most fascinating reading. It teems with good advice, without a trace of the patronizing style sometimes affected by expert anglers who assume that all readers are what in games of skill would be called "rabbits."

Of all methods of taking pike (and he describes all with any element of sport in them), Mr. Spence evidently prefers spinning for them. "The necessity for skill in spinning adds to the pleasure of doing it, and in my opinion nothing is worth doing at all that is not worth doing well"; and again, "a competent spinner will get far more runs than a live-baiter. He must, however, be sufficiently skilful to cast a bait on to a billiards table, fore-handed or back-handed, at twenty to thirty yards on some occasions, or his ascendency may not be noticeable."

Of the two methods of spinning, casting from the reel or from a coil of line on the bank or in a boat, he much prefers reel-casting, and he gives convincing reasons for his preference. His book is packed with matter worth reading, both by the expert and by the tyro. He gives the results of his experience to both. There are few who have nothing and many who have much to learn from them. Whether they will follow his practice of returning all his captures to the water, instead of packing them off to vendors (in the East End of London, for instance, where there is a great demand for them as human diet), is a question for themselves. For myself, I shall take the first opportunity that presents itself of seeing Slapton Lea again, preferably in July, when the sea-beach is gay with yellow sea-poppies and the borders of the sea with viper's bugloss. I am not at all likely to rival his record of pike taken from that delectable water (and returned thereto).

G. G. ASTON.

TUBERCULOSIS REASEARCH.

A Study in Tubercle Virus, Polymorphism, and the treatment of Tuberculosis and Lupus with Oleum Allii. By WILLIAM C. MINCHIN, M.D. (Bailliere, Tindall & Cox. 25*s*.).

In 1907 Professor Hans Much drew attention to the presence of certain granules in body fluids infected with tuberculosis, and, as the result of innoculation experiments, came to the conclusion that these granules (which are now known as "Much Granules") represented a stage in the life-history of the tubercle bacillus and were able, by themselves, to cause the disease. Dr. Minchin has developed Professor Much's theory by suggesting that the granules (which, in their smallest form, pass through the Chamberland filter), are the immediate cause of tuberculosis, that they should be classified as anaerobic yeasts, and that the tubercle bacillus represents a comparatively harmless stage in the life-history of a polymorphous organism.

There is nothing inherently improbable in Dr. Minchin's theory, but it cannot be said that the facts upon which it is based are wholly adequate to support it, for the evidence obtained by the author is entirely morphological and the only control experiment carried out, which revealed the presence of the yeast-like bodies in a filtrate of cancerous material does not, in itself, strengthen the theory.

In this (third) edition of the book the yeasts are illustrated by micro-photographs taken at the enormous magnification of x 4000 by means of the "Davon Super Microscope," and are probably the first examples to be published of work with this instrument, which enlarges our field of research. The photographs show structures which are very like yeasts, but their structure is not sufficiently definite to enable us to rule out altogether the possibility that we may be dealing with minute masses of inert colloid material or with dead bacteria in process of solution.

The second part of Dr. Minchin's book is devoted to advocating the use of garlic oil in the treatment of tuberculosis. This treatment has been used from almost the beginning of medicine to the present day, and Dr. Minchin attributes the common failure in obtaining consistently good results to the neglect of surgical measures, which are often necessary in order to expose the site of the disease to the antiseptic action of the garlic oil.

Purely morphological evidence is bound to be unsatisfactory in dealing with bacteria and other micro-fungi whose structural differentiation is extremely slight, but it would be a pity if equivocal appearances which are difficult to interpret should deter microscopists from following up Dr. Minchin's work and supplementing experimental methods, in this and other departments of bacteriology, by means of high-powered instruments.

F. A. HAMPTON.

THE PRE-WAR MIND.

The Pre-War Mind in Great Britain. By C. E. PLAYNE. (Allen & Unwin. 16*s*.).

This work is a sincere and painstaking attempt to analyse the mind or mentality of the British public before the war. It is an interesting book, although there are some technical blemishes which the author should avoid in subsequent works. The text would benefit from condensation. The numerous quotations of whole paragraphs from contemporary writers give the book a patch-work appearance in places, and some of the quotations do not add much to what the author has already said. Contemporary works are sometimes cited without it being said who wrote them. There is occasionally an atmosphere of scissors and paste.

On the other hand, credit must be given to the author for the wide reading and earnest research which has gone to the making of the book, and to the effort which the author has made to appreciate the point of view of parties, classes, and individuals with whom she is clearly out of sympathy. The style of the book is simple and clear, if a little monotonous; towards the end of the book, however, the style greatly improves, and in certain pages is at high tension.

Some of the best things which are in the book are on the subject of nationalism. The author considers it, with fair show of reason, as "the particular passion which infatuates the world." A remarkable development which has taken place in this passion is that it is no longer represented as conducive to the general well-being; it is sheer group-egoism. The author thinks that the essence of nationalism is the crushing out of individualism; yet she goes on to state, somewhat inconsistently, that the nationalism of Great Britain did not press out individuality. Nationalism in Great Britain developed a high sense of duty. "The fact of the existence of the Empire evokes the Briton's imagination like an epic!"

For her distinctly unfavourable picture of England before the war, and for her comments upon it, the writer of the book relies on authors such as Wilfred Scawen Blunt, H. G. Wells, and G. Lowes Dickinson. Six pages are devoted to an analysis of Wells' novel "Tono Bungay." Belloc's "Emmanuel Burden" is also referred to at considerable length as an authority. *Fin de Siècle* pessimism is repeatedly described as if it were at the core of British pre-war society. The very interesting chapter on panics and the press does not give the other side of the shield—the influence, for instance, of such a journal as the *Spectator* in its attitude towards foreign affairs. The chapter on the teaching of militarism (and also of "navalism," as the author envisages this), is a careful and

informing summary of the views of certain publicists. It is a valuable exposition, but the militarist writers stand forth perhaps in a little too high relief; they were not the only people who were engaged in educating the British public in contemporary history and foreign affairs. The account of the Boer question and the Boer War, although not pleasant reading, is probably not unfair. On the other hand, in the prominence given to the impressive and fervid writings of J. A. Cramb, the author has forgotten that Cramb was practically unknown before 1914, and was only really discovered after the Great War had broken out; while Houston Stewart Chamberlain, with whom Cramb is compared, was quite a national, indeed a European figure, for about ten years before the war.

"The Pre-War Mind in Great Britain" is an interesting, stimulating, well-informed, but not exhaustive work. It is very well worth reading. Although the dark tones are (in the opinion of the reviewer) unduly emphasized, the book is nevertheless a really useful contribution to pre-war history.

R. B. MOWAT.

ANCIENT EGYPT.

The Nile and Egyptian Civilization. By ALEXANDRE MORET. (Kegan Paul. 25*s*.).

The English series known as "The History of Civilization," to which the present book is a recent addition, originated in a similar French series, *L'Evolution de l'Humanité*, and automatically incorporates by translation any book in the latter, although several independent volumes in English have been contributed to it. Egypt was dealt with by Professor Moret for the French series; there was therefore no place for an English writer in the other. But if we question the adequacy of the French genius to present the meaning of Ancient Egyptian history to English people, we cannot cavil at the choice of M. Moret for his part in *L'Evolution de l'Humanité*. He is the ripest and most prolific of living French Egyptologists; and in favour of his suitability for English readers, it may be recalled that he was invited to give the Frazer Lecture at Oxford in 1926.* But there lies the clue to a serious criticism of the book under review.

The Frazer Lecture, as the name suggests, is essentially anthropological in content; and this side of Egyptian studies has always been nearest to the heart of M. Moret. Indeed, he is far more an anthropologist than an historian, and since the further back one goes in Egyptian history the more purely anthropological the material for study becomes, he has tended to specialize in the earlier period at the expense of the later. This tendency is strongly marked in *The Nile and Egyptian Civilization*. Nearly a half of the whole book is taken up with the origins of Egyptian civilization, the history of the earliest separate states, and the evolution of the united kingship, together with an account of the national culture under this despotic monarchy. Yet the "sources" for this period, of a little less than 2,000 years, are probably less than we have from any single century between 1500 and 500 B.C., during which time Egyptian civilization reached its highest point and was of the greatest importance in world-history. During this time we have several proved chronological equations with external events, while for the earlier period Egyptologists are still at variance as to the main dates in the history, though able to compute with certainty the length of many of the kings' reigns. Again, it is not till we reach the New Kingdom, from about 1600 B.C. onwards, that we have sufficient written documents to interpret closely the archaeological evidence, which is practically our only guide in the Old Kingdom and earlier periods to the life of the people. In the opinion of the reviewer the proportions of the book are wrongly conceived for its place in this series. To take a concrete example: the lengthy theorizing as to the nature of what M. Moret calls the Social Revolution in the First Intermediate Period, for which the evidence mainly consists in the absence or destruction of monuments and in a very few not easily intelligible documents of a semi-philosophical nature, might well have been shortened to make room for an account of the intimately documented social disorders and strikes of the XXth Dynasty, of which no mention is made at all. Even in his special field M. Moret is not impeccable, and one is surprised that he should have put forward (p. 147) the old translation "Good Harbour" for *mennefer*, the Egyptian name of Memphis. He does not seem to realize that the city, or rather the new quarter of the city, took this name from the Pyramid of Pepi I (rather than *vice versa*), and he is almost certainly wrong in assuming that it did not become the capital till that Pharaoh's reign. The book should be read with caution by laymen; but so erudite a scholar as M. Moret has always something new for those who can check him.

S. R. K. GLANVILLE.

* The substance of this lecture was published by M. Moret in 1927 in *La Mise à Mort du Dieu en Egypte*.

WIRELESS AND EDUCATION.

New Ventures in Broadcasting: A Study in Adult Education. (British Broadcasting Corporation. 1*s*.).

Owing to the series of articles on broadcasting problems recently contributed by the Manchester Station Director of the B.B.C., readers of *Discovery* will find much of interest in this report, issued by a committee of which Sir Henry Hadow was chairman. Among the chief recommendations it is pointed out that while the provision of recreation and entertainment has been one of the main functions of broadcasting, it is impossible to draw a hard and fast line between recreation and education. To many recreation includes music and drama, also the general talks and debates which keep them in touch with current thought and affairs. This is, in fact, an important form of adult education, but a much larger proportion of listeners than is commonly supposed have particular interests to which special items could make an appeal. The evidence shows that broadcasting could also provide talks which would be welcomed by large sections of the community having their own special interests, such as farmers, housewives and students.

Such provision is dependent for its development on the policy of alternative programmes, which will give a choice of items to all listeners. Alternative programmes should become fully available with the execution of the scheme of regional stations. It is suggested that the most satisfactory method of providing a regular educational service would be to set aside the whole or the main part of one wave-length capable of covering the whole country to a special service of lectures, music, etc. Until this proves practicable, a definite proportion of time in general programmes should be allotted to formal education.

The cost of these and many other developments outlined in the report should, in the Committee's view, be met out of that part of the revenue from licences which is at present retained by the Postmaster-General, over and above the costs of collection and administration.

J. A. B.

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Editorial Notes.

Recent weeks have been notable for the added interest given to aviation, first by the Pacific flight and secondly by the fortunes of the airship "Italia." It cannot be merely by chance that long-distance flights are becoming more sure of success, as every attempt affords its lessons in technique; but there was still a sensational element in the progress of the "Southern Cross," the first machine to fly the longest stretch of ocean which the map presents. The American airmen who last summer flew from New York to Tokyo in fourteen days were widely congratulated on stopping short at the Pacific, in a world flight, yet the improvements within so short an interval had been sufficient to justify the "Southern Cross" attempt. As with the less successful polar flight of the "Italia," this was undertaken in a serious spirit, and we hope that both achievements will now deter the mere sensation seekers. Spectacular Atlantic attempts seem likely to become a regular summer feature, and as we go to press there is evidence that this mania is beginning once more. Credit may perhaps be given to Miss Earhart, the first woman to make a successful crossing, though it appears that her share was mainly that of a passenger. The time has come for public opinion to insist on some measure of control.

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At the time of writing a number of rescue expeditions are preparing to go to Spitzbergen, where the "Italia" survivors are stranded fifty miles from North-East Island. In Sir Hubert Wilkins' opinion it is unfortunate that none of the party had had the advantage of living with the Eskimos and learning their ways of hunting. This remark may well serve to emphasize that his own success in flying across the Arctic a few weeks previously was anything but the outcome of chance. Reading between the lines of his Press comments on the "Italia's" troubles, some of the conditions with which Sir Hubert had to contend himself become apparent. When he called at our offices a few days ago, we were much impressed by the modest personality of this great explorer-airman, and we may perhaps be allowed to express the congratulations of *Discovery* on the honour which the King has bestowed.

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One other flying development calls for remark. We publish on another page the plans of a German inventor, Herr Max Valier, who is now on surer ground than a year ago when he first advocated rocket flying. The first motor-car propelled on this principle has been successfully tested in Berlin, as the result of which the power obtained and other practical factors are now known. The theoretical aspects of flying outside the earth's atmosphere were fully discussed last year in *Discovery*, and we shall await with interest the next stage in the project.

* * * * *

We remarked recently in lighter vein on the work of the Princeton Mission in Peking, where a wall had been built round Yenching University to prevent the activities of marauding war-lords. From the same source we have now received a cutting from the New York *Sun*, in which Dr. J. Leighton Stuart discusses the new Japanese attack on Shantung. This American observer, who was born in China, the son of a missionary, and is president of Yenching University, says that this attack has a deeper significance than a mere incident in the age-old racial conflict of the East. Japan, it appears, is confronted by a birth rate increasing her population 700,000

a year. She has tried colonization, but Canada, Australia and America are closed to her emigrants, and in Formosa and Korea, where she established colonies, the standard of living was too low. Unable to adjust themselves, the Japanese colonists became discouraged and returned home. Another solution offered itself—the industrialization of Japan. To accomplish this she had to develop in China sources of raw materials, and a market, and this process has been going on for a number of years. Now the Nationalist forces, moving northward toward Peking, have cut the Shantung railway and threatened in a single stroke the movement of raw materials to Japan and the chief line of communication to her market. An imperialistic Cabinet is in power in Japan. "Their normal reaction was to save the Shantung railway at all costs," Dr. Stuart remarks, "but it seems to me that in saving the Shantung railway they may lose all China."

* * * * *

The only power in China to-day, we are told, is public opinion. Japan easily can dominate a section of the country such as Shantung, but she is liable to run into a nation-wide boycott of Japanese goods. The Japanese have awakened the only force that can be used against them, boycott being a weapon that China knows how to use with telling effect. Once before the nation was aroused to boycott the products of Japan: students visited the shop-keepers and argued long and earnestly against handling Japanese goods, and where the merchants refused, their shops were looted and the hated merchandise destroyed. During this period the Chinese guests of Dr. Stuart refused to drink tea out of cups made in Japan. Whether the North and South of China will be unified as a result of Japan's aggressive tactics in Shantung—an effect by no means unlikely—Dr. Stuart is sure of one result. Within a few months Japan's trade will dwindle and her largest market will be alienated.

* * * * *

The solution in Dr. Stuart's judgment will be found in watching Japan, for we shall soon see whether the aggressive policy of her imperialistic Cabinet has the support of the people. The industrial districts already have expressed their disapproval, and if this sentiment grows it is possible that the Cabinet will be forced to resign and a more liberal government take its place. China is in a stage of metamorphosis, and from the old loyalties toward ancestors and family, she is turning to a national consciousness and a sense of public welfare. The change is not an easy one, for it strikes at the root of tradition and race psychology, but toward this end the position in Shantung may eventually prove a powerful force. For this reason we select the incident to give the foregoing views, which, coming from one so impartial and well-informed as Dr. Stuart, provide a new clue to the Chinese puzzle.

* * * * *

Until quite lately the exact nature of luminescence in certain marine animals was not known. It is now discovered to depend on one of those phenomena in nature which Professor MacKinnon, in a lecture at the Royal Institution, appropriately calls "Life's unexpected partnerships." Within the animal's body there are captive bacteria having the power to emit light, which in the cuttle-fishes, for example, live in the cavity of the so-called accessory nidamental glands. In these animals there are elaborate devices for insuring that the developing young receive their bacterial supply from the parent. The advantage gained by the cuttle-fish is probably related with bringing the males and females together at the time of mating, but it is not yet obvious what special advantage accrues to the bacterial partner. The majority of the other known associations of the kind have probably to do with food-capture and with its digestion, but in all the most recently described examples, while symbiosis is suspected, it has not been scientifically proved. It has still to be shown experimentally that the host cannot get on without its guests.

* * * * *

A new appeal has been issued by the British School of Archaeology in Jerusalem, of which Sir Frederic Kenyon is President. The school was founded in 1919 to provide instruction for students, and training for excavators and inspectors of antiquities. For many years, British explorers have taken a leading part in the rediscovery of ancient sites in Palestine, and the interpretation of Hebrew and early Christian history. Under the Mandate from the League of Nations for the Government of Palestine, while Great Britain is responsible for the custody of all ancient remains, facilities for archaeological exploration are open to all nations: there are already American, French and German institutes for the reception of students and travellers, and for the conduct of excavations. It would be a disaster and a disgrace if British scholars were compelled to depend on foreign institutions for the necessary facilities for their studies, and if the operations of the Palestine Exploration Fund and other British societies were hampered by lack of a working centre in Jerusalem. To maintain the school on its present modest establishment, an annual expenditure of at least £1,150 is necessary, and we commend the work for generous support.

Recent Excavations at Cyrene.

By Luigi Pernier.

Professor of Archaeology in the University of Florence.

The first excavations at Cyrene were carried out by British officers in 1860-61. Work was resumed in 1910 by an American expedition, and after the Italian occupation of Tripoli it was continued by the authorities. Since 1925 special encouragement has been given, and a first article by Professor Pernier here describes the main discoveries to the end of the 1926 season.

THE Fountain of Apollo at Cyrene, which attracted the original Greek colonists to this north African site in 630 B.C., rises from a subterranean channel about three hundred yards long and a yard high. This was investigated for a short distance only by explorers in the past century, P. della Cella, the Beechey brothers and Porcher. The name of the latter appears among the inscriptions which cover the wall of the subterranean passage, followed by H.M.S. "Assurance," the name of the vessel used for transporting to London the statues discovered in Cyrene by Smith and Porcher in 1861. G. G. Porro in 1913, and, with greater thoroughness, G. Oliverio in 1916, explored the narrow canal as far as its inner opening, beyond which it is impossible to penetrate, and Oliverio, after surmounting great difficulties, succeeded in making drawings and photographs which revealed the interior.

THE NORTH-EAST HILL OF CYRENE.
View showing the general character of the site. The eastern part of the excavations, in the foreground, includes the *Thermae.*

This canal is composed of two parts. The exterior and most ancient constitutes the Fountain of Apollo (celebrated by Pindar and by Callimachus), which was the cause of the founding of Cyrene on that day when the colonists from Thera, guided by the Libyans, halted before the copious stream of its fresh and limpid water. The interior was afterwards artificially constructed, corresponding with the Sacred Grotto of the Nymphs (*Nymphaeum*), and it was here that the walls and vault bore inscriptions, some incised in the softer layers, others in relief produced by the application of small rods or reeds of clay on the rock. There is reason to believe that sacrifices were offered in the grotto, near the spring, and the ancient inscriptions, dated with the name of the Emperor or the Priest of Apollo, mention priests who entered the precincts for liturgical purposes and pilgrims who came to register the successful accomplishment of their vows.

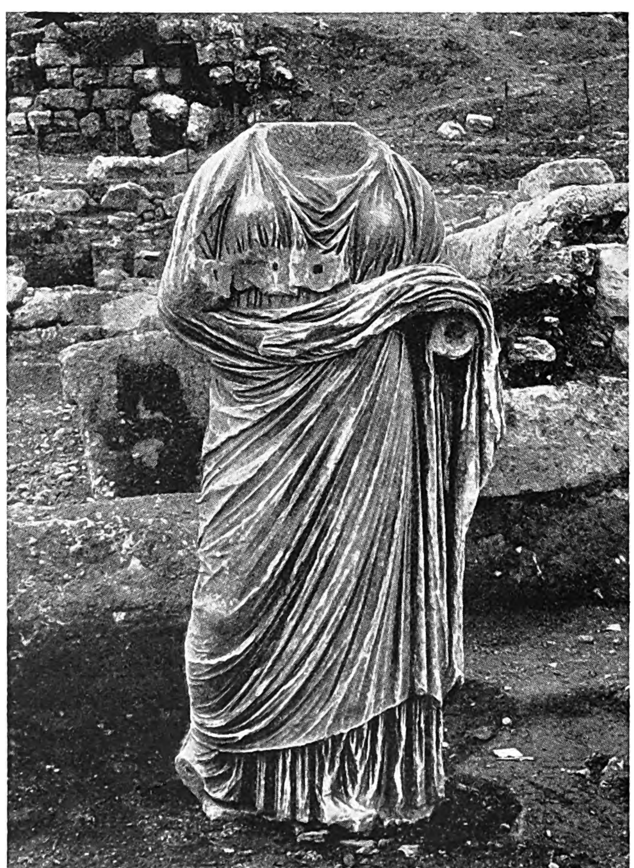
Most important finds are two striking Greek inscriptions. One of these, called "the Stele of Augustus," is cut into a block of marble, measuring two yards in height, about three-quarters of a yard in breadth at the base, and half a yard at the top, and comprises 144 lines of minute writing. This block must have stood originally in a prominent position in the Graeco-Roman Agorà, which lies on the elevated plain in the south-western part of Cyrene; later, it was placed on one side to serve as a seat in an edifice also in the Agorà; and to the fact that the inscription was concealed by being turned to the wall, we owe its remarkable preservation. The inscription consists of two parts: the former includes four edicts of the Emperor Augustus in the year 7-6 B.C., relating to the judicial and financial administration of the Province and also to several Roman citizens, residing in Cyrene, and placed under surveillance for suspected political tendencies. The second is the text of a message from the same Emperor, who, in the year 4 B.C., communicated to the inhabitants of Cyrene a senatorial proposal, initiated by the Consuls for that year, G. Calvisius Sabinus and L. Passienus Rufus, for the protection of the colonists from the violence and rapacity of the public officials.

"This proclamation," writes Augustus, "is issued for the purpose of assuring the inhabitants of the Provinces that I and the noble Senate will provide for the safety of those entrusted to us, allowing them to suffer neither molestation nor spoliation."

The importance of this inscription in regard to the juridical and political decrees of Rome is equalled by the value of the second inscription in the field of Hellenic religious documents. This second incised block had also been employed as a seat in a large room of the *Thermae* which the Byzantines had reconstructed along the eastern side of the Sanctuary of Apollo, below the Fountain of the same name. The Byzantine stucco fortunately served to protect the inscriptions which were cut upon three sides; the central and the left columns contain documents of Delphic law and ritual; in the right column are recorded the names of forty-three cities of Greece and of two queens, Olympia of Epirus and Cleopatra of Macedonia, who during a famine which lasted for five years (336-330 B.C.) received about 29,000 tons of grain from Cyrenaica. This is an impressive and incontestable proof of the agricultural capacity of that region. Silvio Ferri discovered this precious block in 1922, with other blocks of marble also bearing inscriptions, one of which has preserved the constitutional tables of the Cyrenaic Republic. The inscription of the Delphic Laws may be referred to the last decades of the IVth century B.C. A kind of religious codex, it transcribes and collects Delphic responses and ancient racial memorials, relying chiefly upon oral traditions and still earlier inscriptions. The responses are largely composed of ritual prescriptions for obtaining purification after contamination, even when involuntary, and often refer to suppliants who were seeking release either from pecuniary debts or from the crime of shedding of blood.

Just as in the writings of Pindar and Callimachus we find frequent mention of personages and places of Hellenic Cyrene, so these inscriptions abound in allusions to local topography; the Agorà, within the precincts of which Pindar placed the tomb of the first King of Cyrene, is the one where the Stele of Augustus was erected; the regulations for purification, noted in the *Lex Cathartica*, were performed in the temples and on the altars which were seen by Pindar and Callimachus. One of the paragraphs of this law commands "the recent bride to descend into the *Nymphaeum* of Artemis during the Artemisian festivals"; adding, "Let it be as soon as possible." Another inscription records the release from his oath of Lysimachus, son of Lysimachus, directly after the celebration of the Artemisian ceremonies. This actual temple, the Altar of Artemis, and the subterranean *nymphaeum*, have all been brought to light near the temple and the Altar of Apollo.

The monuments thus discovered in Cyrene give the solid basis of truth to the records preserved by the inscriptions, and the latter, together with the literary traditions and with the statues, enable us to rehabilitate the silent ruins and to people them with the personages of ancient days. Although conducted with praiseworthy zeal, the excavations have thus far revealed but a small part of the vast city once girdled by a wall with turrets and a zone of cemeteries more grandiose than in any other city of Greece and perhaps of the classical world. The general topography, however, as suspected by H. Weld-Blundell in 1895, and as shown by its most vital arteries, is as follows: On the hill to the south-west we have the *Forum* and the *Acropolis*; on the eastern side of the Acropolis, cut through the solid rock, the highway of which Pindar speaks as "resounding with the tramp of horses" (referring no doubt to the sacred processions), descending from the Agorà to the Fountain of Apollo; in front of the latter, extending in a

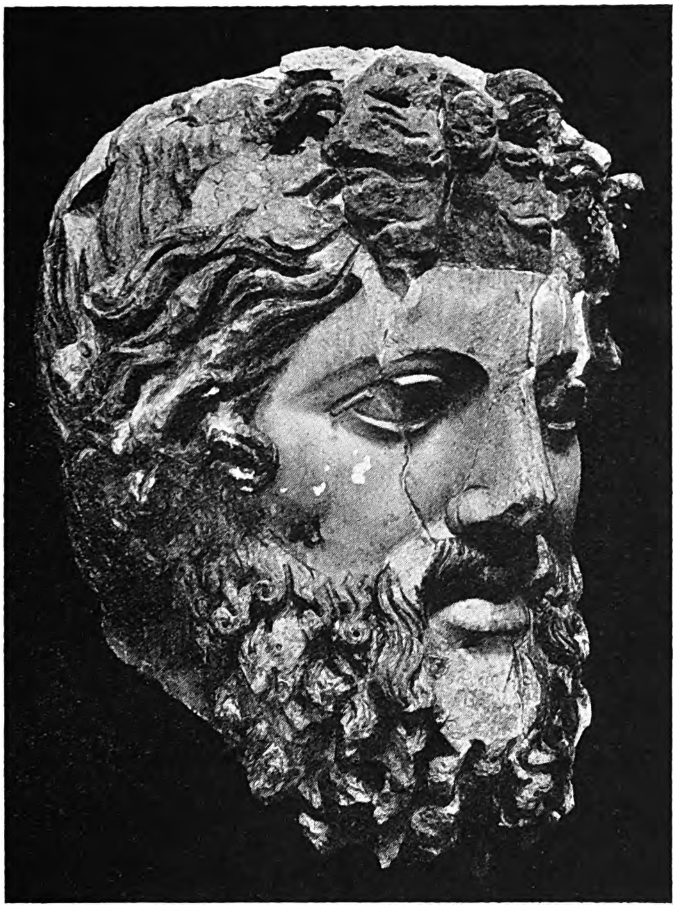


A HEADLESS FEMALE STATUE.

This marble statue is of the type of Artemisia, and was found in the area between the Sanctuary of Apollo and the Theatre at Cyrene

northerly direction, the terrace with the Sanctuary of Apollo, and towards the west the Theatre.

On the hill to the north-east stood the great Doric Temple of Jupiter, in which was found an admirable head, probably a copy of the masterpiece of Pheidias, but executed in reduced proportions during the period of the Antonines. This image of the Supreme Deity, with its gilding and with the shining ivory-like polish of the marble, shows an imitation of the chryselephantine technique of the great original at Olympia, and also resembles the heads of Jupiter on the gold staters coined by the Sacred Mint of that city in the Vth-IVth century B.C.



MARBLE HEAD OF ZEUS.
Unearthed in the *Olympieion* at Cyrene, this marble head is a replica of the Olympian Zeus of Pheidias. The piece is noteworthy for its excellent state of preservation.

The excavations between the years 1913 and 1924 were devoted to bringing to light and illustrating the Roman monuments of the Agorà and the sanctuary, only in some cases reaching the Hellenic strata. In order to make a complete excavation of the stratification and to trace the history of the monuments from the foundation of Cyrene (about 630 B.C.) up to the Byzantine period, the Ministry of the Colonies and the Government of Cyrenaica in 1925 instituted a special mission.

First comes the Temple of Apollo, identified by Smith and Porcher in 1861, which has now been completely excavated so that the various stages of its history for eleven centuries are revealed. The temple, of the archaic Doric order, was enclosed by six frontal and eleven lateral columns with a prolonged cella and interior recess (*adytum*), each divided into three aisles by two rows of seven columns and with subterranean chambers for the preservation of the treasure. By its arrangement and structure this temple resembles the most venerated fane of primitive Greece, the Temple of Hera at Olympia, and also recalls important characteristics of the architecture of the Mycenaean palaces. The *adytum*, a sacred enclosure inaccessible to the laity, which in the Temple of Apollo at Delphi we find reserved for the exclusive use of the Pythia, confirms the deduction of Ferri from a passage in the Delphic ritual of Cyrene, that in this temple also oracular responses were made.

When the building became dilapidated from age—a natural consequence when we remember that the walls were constructed of crude bricks, the wooden covering adorned with ornaments of terra cotta and the columns composed of painted tufa—the Romans, having created a new province of Crete and Cyrene, wished to give renewed splendour to the city, and set about the work of enlargement and renovation. They renewed from its foundations the base of the peristyle, increasing its size and raising it upon three high steps with new and heavier Doric columns. The remains of the primitive peristyle were buried, but the ancient cella (of which part of the brick walls and the internal columns were left), was surrounded by walls constructed of blocks of tufa and placed in communication with the raised peristyle by means of a broad staircase.

We read in the inscriptions that during the insurrection of the Jews ("*tumultus iudaicus*") of A.D. 115-16 the edifices of the sanctuary were destroyed and burned; later the restoration was ordered by Hadrian; the Temple of Apollo met with a similar fate, and the inscriptions further record that, under Commodus, Decimus Cascellius Aristoteles initiated the renovation of the cella. In the following period priests and private individuals gradually rebuilt the exterior colonnade.

In A.D. 394 a violent earthquake overthrew the temple, causing it to fall upon the surrounding buildings and reducing the sanctuary to a mass of ruins, in the midst of which the Byzantines erected a small church and a bath-house, employing for this the existent marbles, even when inscribed, which had served for the altar and for votive inscriptions.

The northern limit of the sanctuary is formed by a high wall of about 400 metres in length for the support of the artificial esplanade; on the eastern confines the latest excavations disclosed a Hellenic gateway and a *propylaeum* of the Roman Imperial time, and it is intended to continue in a southerly direction from the latter point towards the Fountain of Apollo, following broad existent stairways, and also to the west, towards the theatre. The sacred precincts, however, comprising the area between the *Apollonium* and the *Thermae* in the eastern zone have now been cleared as far as the Hellenic pavement. From the Roman *Propylaeum* where the tetrastyle façade is now being restored, the visitor may at present proceed along the ancient Sacred Way. Immediately on his left he will perceive a graceful Greek fountain ornamented with Doric half columns and four spouts, once adorned with lion's heads. A little further are the *Plutonium*, including the Temple of Pluto, of whom there was found a figure in tufa with the head and extremities in marble; the Temple of Proserpine, where the divinity was represented in a beautiful Roman statue of marble, copied from an Hellenic original of the end of the Vth century B.C.; and a chapel of Serapis, in which was discovered a fine statuette of that god seated on a capacious throne, possibly an imitation of the famous statue made by Bryaxis for Alexandria.

Turning towards the north-west, the Via Sacra leaves on the right another temple of most ancient origin and passes between the enclosure of Artemis and the great Altar of Apollo, which latter measures twenty-three metres in length. On the northern side of the altar is cut in the large fine characters of the IVth century B.C.: "Philon, son of Annikeris, dedicated the altar, the one of Parian marble." Before Philon undertook the work of facing with marble the three steps and carving the table and sides with fine ornamentation in the style of the Erechtheum, the altar had been a simple construction in blocks of tufa of the same age and appearance as the base of the primitive Temple of Apollo. We found only the lower portion of the tufa altar; the marbles of Philon had been removed by the Byzantines for the paving of their baths. These facts having been ascertained, we restored to the altar its marble ornamentation, scrupulously fitting each piece into its original place; and now we may behold the splendid precedent set by the wealthy Greek of Cyrene to his descendants who have embellished modern Athens.

THE GREAT ALTAR OF APOLLO.
This altar was refaced in the IVth century B.C. by Philon, and measures over twenty yards in length. The marble facing, removed in the Byzantine age to floor a bath, has now been replaced.

In the immediate vicinity of the Altar and of the Temple of Apollo, worshipped under the title of Carneius, was a continuous series of sacred monuments, intermingled with staircases and fountains. Exactly to the south of the altar stood the temple dedicated by T. Claudius Jason Magnus to Apollo Ktistes; proceeding westward we observe a column in the form of the silphium stem (the emblem of Cyrene), dedicated by Pratomedes; a circular *nymphaeum*; the Temple of Apollo Nymphagetes; a second fountain, and an oratory to Isis. Of the numberless offerings the majority are statues; the spade has unearthed not only numerous bases with the names of those who dedicated them, but many rare and valuable objects, such as a rough statuette of a Maiden (Kora) in iron, a unique proof of the use of iron for primitive Hellenic statuary, and a small bronze head which portrays in the exquisite original art of the Vth century B.C. the grave and noble lineaments and expression of a victor, crowned after the sacred contests.

The Temple of Artemis (of as ancient date as the *Apollonium*), enlarged and embellished by the Romans, has also its majestic primitive altar of tufa as well as its depository for the gifts, and its treasure with votive offerings. These consisted of small vases, lamps, and statuettes of terra cotta and an infinite variety of minute objects in stone or precious metals such as pendants, necklaces, ear-rings, and diadems, offered by the ladies of Cyrene in religious fervour or in

expiation of peccadillos not included among the penitential offences. The subterranean *nymphaeum* to which the women descended for the rites of purification, according to the prescriptions of the Law, has been discovered at the north-east corner of the *Artemisium*, below the Temple of Artemis Infera, of whom we have also found the threefold image in painted tufa.

To the north and west, that is, along the retaining wall and towards the theatre, other sanctuaries, porticoes and depositories for offerings give the ruins of the terrace a number and variety of monuments that may be compared only with the sanctuaries of Delos, Delphi and Olympia. Cyrene may even vie in grandeur with Pergamum when the excavations have been continued to the Acropolis and to the city beyond the *Forum*, where already have been brought to light the chief roads, the Capitol, the State Archives (the *Tabularium*), the Temple of Ceres with the inscription of the prices of vegetables, the great Portico dedicated to Jupiter the Saviour, Roma and Augustus, and the spacious altars to the Divinities of the Agorà.

THE SANCTUARIES OF APOLLO AND ARTEMIS.
In the vicinity of the Altar of Apollo and of the Temple of Artemis was a series of sacred monuments, with staircases and fountains. When excavations have been completed, the whole scene may vie in grandeur with Pergamum.

"On the boundary of the Agorà lies Aristoteles Battus, the first king, revered as a hero," sang Pindar in his Vth Pythian Ode. It is not surprising that such an honour should have been paid the founder of the glory of Cyrene, who in obedience to the words of the oracle, had safely guided thither the colonists from the island of Thera; but what explorer would have dared to hope for the discovery of his mythical burial-place? As the Tomb of Romulus has emerged from the ruins of the Forum Romanum, so we believe we have discovered in the Agorà of Cyrene the sepulchre of Battus—a small round structure on the boundary of the Agorà in an area which still preserves indubitable traces of having been used for religious observances. In this, as in many other instances, scientific excavation has proved the authenticity of what were once considered legends or the creations of fancy.

REFERENCE:—Volume IV of the archaeological reports of the Italian Ministry of Colonies (published in Rome by Alfieri & Co.) contains 39 plates illustrating the Cyrene excavations conducted under its auspices.

A New Maya Treasure.

A TURQUOISE mosaic recently discovered in the Temple of the Warriors at Chichen Itzá, Yucatan, is claimed to be among the finest known examples of aboriginal American art. It is the first to be found within the Maya area and in a recognized and datable archaeological horizon. From the preliminary excavations described in *Discovery* last January it will be recalled that the Temple of the Warriors was found to be the last of three structures erected on the same site. The new treasure is the outcome of further digging by the Carnegie Institution expedition, and it was unearthed in the inner chamber of an earlier buried temple. A systematic search had been made wherever there were traces of altars for ceremonial treasure, and in the inner chamber a specimen was at last revealed in unexpected circumstances. The floor below the area assumed to have been covered by the altar tables, which had been removed, was cut into without success, when near the wall of the chamber the pick happened to touch an object unlike the floor materials. Presently a buried vessel was exposed, in which the mosaic was discovered.

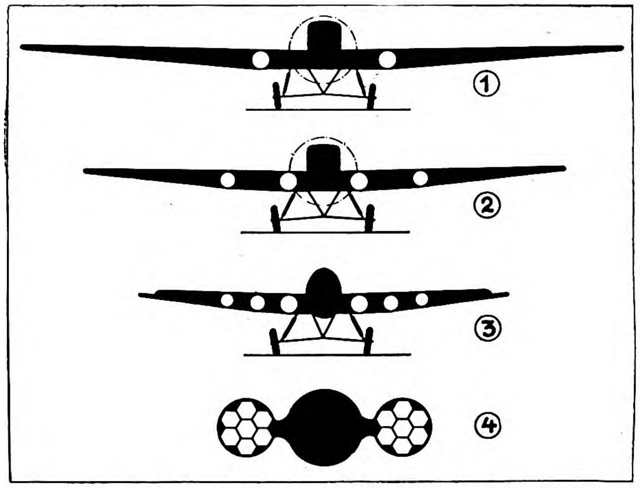
Most of the cut pieces are highly polished, and on them were found placed the bones of a bird, the component parts of a necklace, and a highly polished ball of jadeite—a symbol used by the Maya priests for divination purposes. The plaque is between eight and nine inches in diameter, but the wooden body has completely decayed, with the result that the mosaic is held in place only by the paper-thin film of adhesive matter by which the pieces were encrusted upon the wood. Two-thirds of the mosaic is relatively intact, and the rest is sufficiently related to permit restoration. In addition to an elaborate arrangement of petal-shaped divisions, enclosed by a stripe of brilliant red lacquer, the pattern embodies the head and claw of a reptilian creature, and consists of 3,500 pieces of turquoise. Restoration is now being undertaken by an expert from the New York Museum of Natural History, who has travelled specially to Yucatan for this unusually delicate task.

Can We Fly to the Stars ?

By Max Valier.

The inventor of the rocket car that was successfully tried out a few weeks ago in Germany, here discusses the test, and outlines proposed flying developments. In translating Herr Valier's manuscript we have appended some Press comments on the problem, including the announcement of a five thousand francs annual prize.

PRACTICAL tests have now proved the possibility of propulsion by the rocket-principle engine. For several years the author has been trying to explain to a sceptical world how flight beyond present-day limitations may become possible.* He claims that the rocket-principle engine can be so far developed that it will outshine all other engines, from the point of view of high power with minimum weight. And now, on the Opel motor racing track at Ruessenheim, near Berlin, a test has been made with a motor-car fitted with a rocket-tube engine embodying the author's principles. The result shows that not only can enormous speeds be obtained, but also that the machine is under complete control. This last point is most important.



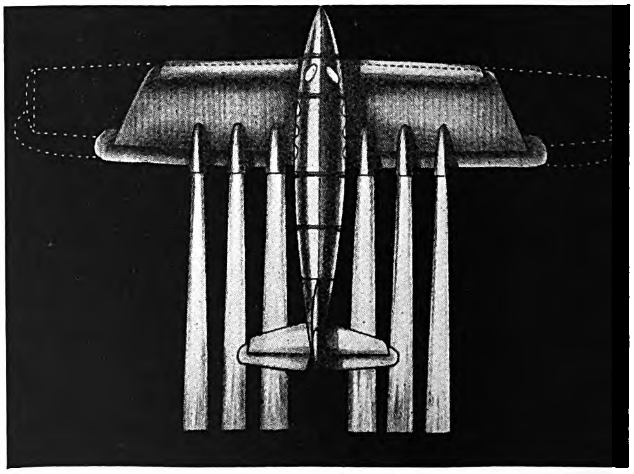
PROPOSED EVOLUTION OF THE ROCKET SHIP.

In these four stages are seen a standard aeroplane carrying two rockets and auxiliary propeller, evolving finally to a wingless torpedo with fourteen ejectors.

When the rocket car was started up, with its series of rocket tubes protruding from the rear like a battery of light guns, it shot off the mark with a tremendous explosion. Within seven seconds it attained a speed of approximately 100 kilometres per hour, a speed which it nearly doubled during the run. As it dashed by the spectators' stands it was feared that the car would run out of control, and there was relief when, at the curve, the driver shut off the engine, turned, and restarted the rocket batteries, on coming into the straight again. Eventually the machine was pulled up " dead."

To test the power of rockets, a further experiment was carried out on the Opel racing track. A hugh rocket prepared by Herr Sander, the life-saving apparatus expert, was erected on a long pole, like a slender telegraph pole, which acted as " stick." The size can be judged from the fact that it took six men to erect it. When fired the rocket sped heavenwards at a speed calculated at 1,000 kilometres per hour, and disappeared across the sky, pole and all, as a thin black streak.

The next step is to build a rocket-propelled car of more special design, with which to attempt speed records. This will lead to the aeroplane fitted with auxiliary rocket tubes for high flying. The height records will be attempted with a view to getting experience of how the apparatus, and especially the human driver, are effected by the thinner air and excessive cold of the upper regions of the atmosphere. It is realized, of course, that the airmen must be protected against these conditions by artificial " equalizing " means. Step by step the wings of the machines in successive experiments will be reduced and the rocket tubes increased in size or number,



THE THIRD STAGE.

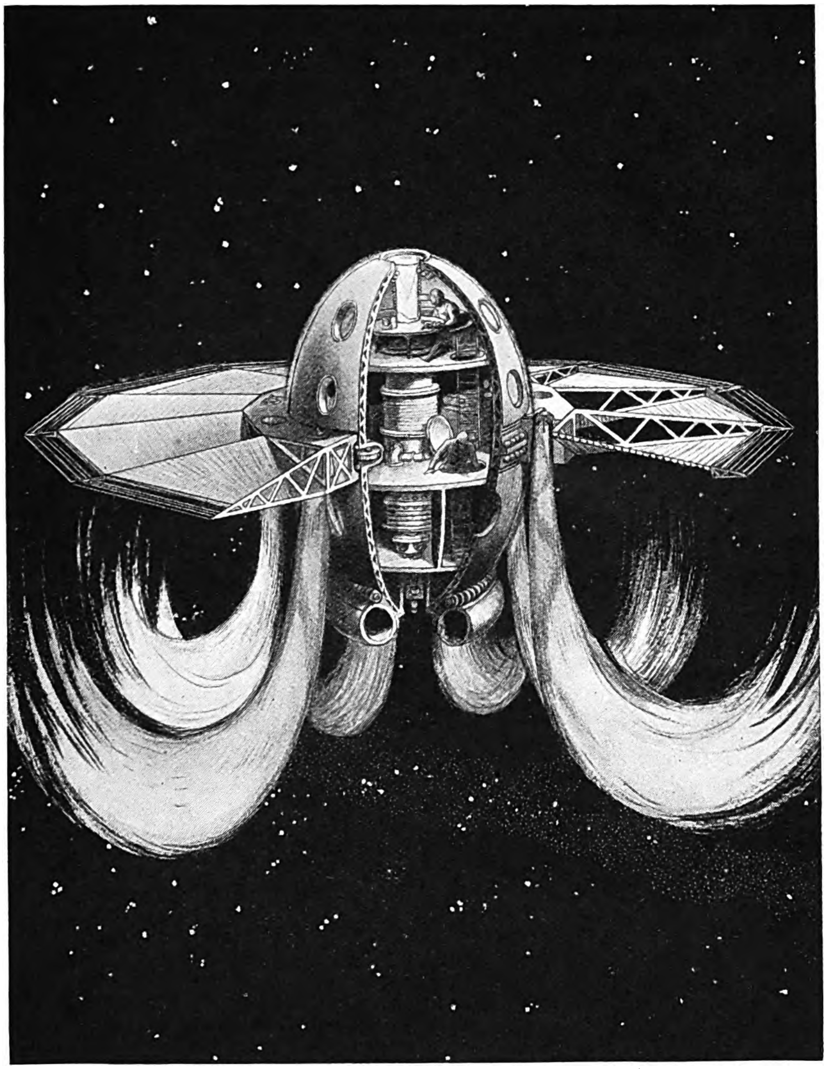
At this stage the aeroplane will no longer employ a propeller and will be constructed with shorter wings and streamline body.

* The first English article was published in *Discovery*: " Europe—America in Two Hours ? " 1927, p. 187.

until the machine resolves itself into a huge air torpedo propelled by the gas molecules of the exhaust.

As was remarked in the previous article in *Discovery*, the objection has been raised that voluntary movement and steering of a rocket ship would be impossible in the empty space beyond the earth's atmosphere, because the motor of the ship would find no resistance for its power development. In travelling through the atmosphere, however, the rocket does not rely on the support of the air, but moves by its own internal energy through it. The space-ship likewise would move forward by means of the expulsion through the exhaust nozzle of the exploded gas, whereby a continuous recoil—similar to that momentarily occurring when a gun is fired—would exist to drive the ship onward.

We have still to wait patiently for actual achievement in these directions. The author and the Opel engineers have shown that rockets can drive a car, but of "space," actual void or even the thinner strata of the earth's atmosphere, we know nothing. There may be many things to contend with which have not yet been thought of. And what of the human heart? Strange things happen in the human frame in artificial conditions. Shall we have to evolve a new race of men?



A SPACE SHIP BOUND FOR MARS!
The imagination of the artist is here untrammelled by scientific considerations, and his glimpse of the future is reminiscent of Jules Verne. The leisured demeanour of the aviators in the cabin, suggests that the exterior of the ship is designed to revolve independently as it whirls on its way to Mars.

In connection with the rocket car test, a statement as to flying developments was made by Herr Fritz von Opel, the head of the motor firm which built the machine. As reported in *The Times*, he said that aviation was still "labouring through the murky realms of the earth's atmosphere, while a few miles higher regions offering less resistance and better weather held out the possibility of ten times greater speeds." These regions had remained unexplored because the combustion engine needed a supply of air which they did not provide. It was necessary to find a motive force which could dispense with air, and they believed they had found this in the rocket. The test performance vindicated the principle and concluded the first stage of their programme. The next steps, he predicted, would be divided into six stages:—

(1) An attempt upon the world's speed record, in order to show that all previous speeds could be surpassed.

(2) The construction of the rocket aeroplane.

(3) The exploration of high altitudes; recording instruments would be "rocketed" to hitherto unknown heights. Animals would also be sent up in order to ascertain whether, in addition to the known but surmountable difficulties of temperature, pressure, and lack of oxygen, other dangers existed in the unexplored altitudes.

(4) A "manned rocket"; the problems of the supportable pressure at the moment of "firing" and the security of the airtight "passenger chamber" would be progressively approached.

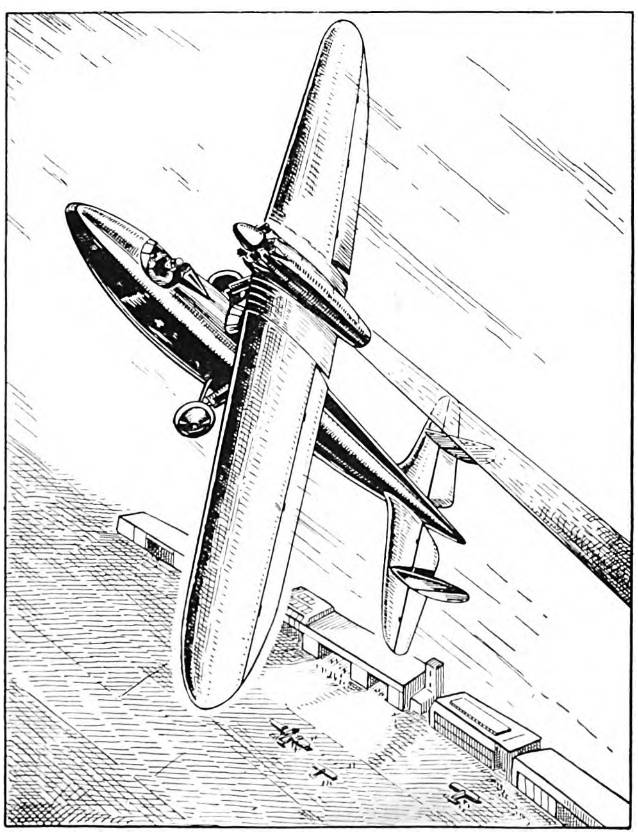
(5) The building of aeroplanes suitable for flights

in altitudes between twenty and thirty kilometres (about twelve and eighteen miles); speeds of above 1,000 kilometres (625 miles) an hour are expected. A world flight in less than half a day should prove to be possible.

(6) Efforts to reach ever-increasing speeds and altitudes; as to the possibility of reaching neighbouring worlds, there was no need to waste thought upon such ideas just yet, Herr Opel concluded.

It appears, however, that the problem of flying to the stars is already attracting attention in France, where it is popularly called " astronautics." According to a report in the Philadelphia *Public Ledger*, M. Peletrie, who made his reputation twenty years ago as a designer of light engines and streamline airplanes, is offering through the Société Astronomique an annual prize of 5,000 francs for the best essay upon astronautics.

That the creating of the essay prize is no idle gesture is proved by the fact that in scientific circles there is a " school " of astronauts. Peletrie is the founder, and as many as fifteen years ago he made first mathematical investigations of interplanetary travel.



A SINGLE ROCKET MACHINE.

In an early stage experiment in rocket flying the aeroplane might be fitted with a single battery of rockets, in place of the usual petrol engine.

Darwin To-day.

So many discoveries have been made in biology during the seventy years since the publication of " The Origin of Species," that the idea is commonly held that Darwin's original theory is now largely out of date. The greatest interest therefore attaches to an introduction Sir Arthur Keith has contributed to a new Everyman Library edition (Dent, 2s.), which in ten pages provides a modern commentary by one whose knowledge of the subject is unsurpassed. It is important to know the alterations which Darwin found it necessary to introduce in successive editions, hence Sir Arthur gives a list of these in the opening pages, but Why, he asks, should so many critics continue to misunderstand the essentials of Darwin's theory of evolution?

The truth is that Darwin himself was at fault, in amplifying the title of his theory with the words " By means of Natural Selection." Plainly this was a misnomer, as Darwin placed in a most conspicuous position, at the end of his introduction, the qualification that " natural selection has been the main but *not the exclusive* means of modification." Darwin perceived that another main factor is concerned in evolution, the " productive " factor, which gives rise to the materials of evolution—the points or characters wherein one individual differs from another. As to how such " variations " are produced, every chapter of his book finds Darwin declaring that he does not know. The only point of which he felt certain was that individual differences do not arise by chance.

Every year modern biology is learning more and more concerning the production of variations, which are regulated by an extremely complicated series of interacting processes; but nevertheless Darwin had wisely made full allowance for the ignorance of his time and for future knowledge. " What we discover now and what our successors will find out . . . will serve to add fuel to the fire kindled by Darwin: further discoveries cannot extinguish that fire. Our knowledge of the laws of heredity increases rapidly; Darwin expected such an increase, and made full allowance for it. He knew nothing of Mendel, but he exemplifies the law now known by Mendel's name. However much our knowledge of heredity may progress, Darwin's position will be but strengthened."

" Critics often accuse Darwin of ignorance, whereas it is their knowledge of this book which is at fault," Sir Arthur Keith concludes. " It is never safe for a biologist to announce a discovery if he has not read and mastered ' The Origin of Species.' "

The Close of the Age of Mammals.

By H. J. Massingham.

After giving some startling facts to show how rapidly man is exterminating other forms of mammalian life, Mr. Massingham concludes: "It is very certain that if the students of evolution do not take quick steps to guard its inheritance . . . posterity will exclaim 'But what have you left us?'"

It is a curious psychological problem as to why so little interest or concern has been aroused over the virtual ending of an historical and prehistorical period, corresponding in length with a geological one, and roughly known as the Age of Mammals. Our own age is one in which general information is rather over—than under—diffused, with the result that a vast mass of trivial matter is made common property; the study of animal life has been developed to such a pitch that the danger is more one of over-specialization than of incomplete knowledge, while what is vaguely termed the humanitarian movement is no longer the forlorn effort of a small minority beating in vain against the *vis inertiae*. The boundaries of the world have been drawn into narrower and yet narrower compass by the progress of mechanical invention, and a Bestiary of fabulous animals printed only 300 years ago would excite the ridicule of the most illiterate to-day. Yet a modern world which is so widely educated, possesses such general stores of knowledge, and prides itself upon new susceptibilities, has been heedless or indifferent to a tragedy whose irrevocable magnitude leaves the imagination aghast. That tragedy is perhaps best summed up in the title to this article—"The Close of the Age of Mammals."

Universal Destruction.

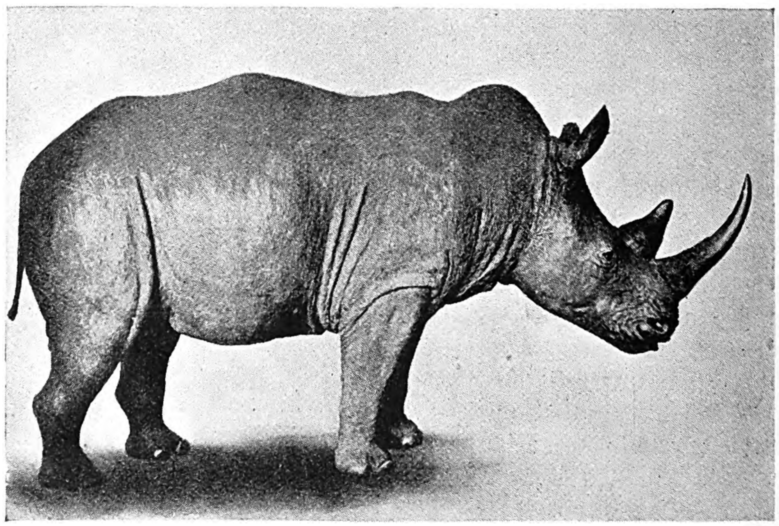
Of the destruction of wild mammalian life on a universal scale there can be unhappily no doubt, and I will quote some authoritarian figures and comments to illustrate it, so that I may avoid the impression that so stupendous a phenomenon as the last phase of a distinctive epoch which opened in the Eocene period is a misuse or extravagant use of the term. We have first of all to record the total disappearance of such animals and birds as the Blue Buck, the Quagga, Burchell's Zebra, the Passenger Pigeon, the Great Auk, Steller's Sea-Cow, some of the great Land Tortoises, and other species of bird, mammal and reptile within the last hundred years. If no radical change takes place in the rate, scope, and inducements of present-day intensive slaughter, these vanished ones can only be the precursors of a host, and, of course, those animals which are nearing or have crossed over into the desolate country of extreme rarity are twenty times the number of those who will never again be seen on the earth.

Let us take a brief survey over wide continental tracts so as to observe the general status of wild life more closely. India, for instance, was scientifically examined with a view to such an estimate by the Faunthorpe-Vernay Expedition less than five years ago. Lieut.-Col. Faunthorpe found that the Indian Antelope (*Antilope cervicapra*) "is now very rare," while not a single member of the Great Indian Bustard (*Chariotis edwardsi*) was seen by the expedition, nor, in spite of careful inquiries, was any live specimen reported. The Brow-Antlered Deer was declared extinct all over the "dry zone" of Burma, and the once common Swamp Deer was very scarce. The Indian Gazelle (*Gazella bennettii*) was reduced to a like poverty of numbers by the method of driving the terrified animals into ravines with nets stretched across them. In the once teeming country of Nepal Terai, it is now, said the head of the expedition, "extremely unusual to see any deer at all." The Pink-headed Duck (*Rhodonessa caryophyl-lacea*) is now extinct, while the Great Indian One-horned Rhinoceros (*Rhinoceros unicornis*) only survives in a small district of British Assam. Both the other Rhinoceri of South-eastern Asia (*Dicerorhinus sumatrensis* and *Rhinoceros sondaicus*) have become so rare as to be in urgent need of the most stringent protection. Sir Hesketh Bell only the other day (16th May) described a new method of taking Orang-Utans in Sumatra which is depopulating their remaining haunts. With these facts before him, it is not surprising that Lieut.-Col. Faunthorpe concluded that "within a measurable space of time there will be practically no game (outside the Government Forest Reserves) left in India."

The Decline in Africa.

The story of the decline in the wonderful and varied mammalian fauna of Africa has been so gloomily a dramatic one that knowledge of it is more widely distributed. It is unnecessary, therefore, to recapitulate its main features. The work of the hide-merchant, the ivory-hunter, the trader in captive animals, the irresponsible big-game hunter, the settler and the blinded tsetse-fly expert, has been done with

that degree of efficiency which has excluded wisdom and humanity. The data, collected by game-wardens and naturalists, and scrutinized by such a body as the Society for the Preservation of the Fauna of the Empire, is in no doubt, and yet reads like the sensation-mongering of the yellow journalist. Only thirty or forty animals remained of the great elephant herds that once roamed the highlands of the Addo in South Africa. The demand for leather from zebras resulted in the destruction over a very short time of 12,000 head in one small district. When the theory was dominant that the ravages of the tsetse-fly could only be checked by grand scale battues against all large mammals, incredible holocausts were made of them, reminding one of the huge massacres of bison in America, when the plains were being opened up. It was then discovered that the worst infected regions were those associated with the greatest paucity of game, while in Tanganyika the wholesale destruction of game has "diverted the fly to man."



THE WHITE RHINOCEROS.
The latest census of 1926-27 shows that only 150 specimens remained of this rhinoceros (*r. Simus*). It is the third largest land mammal still living, the height of the specimen here shown being 5 ft. 5 in. at the shoulder. (Photograph by courtesy of the British Museum (Natural History).)

By the 1926-27 census, only 150 of the White Rhinoceros (*Rhinoceros simus*), the third largest land mammal still living, were left, while the Annual Report of the Transvaal Game Reserve in 1925 described the Black Rhinoceros (*Rhinoceros bicornis*) "as a type fast disappearing from even the best game countries of Africa to-day." The same report drew attention to "the virtual extermination" of the warthog between 1914 and 1919. A similar reckoning, more than confirmed by the investigations of the late Sir Albert Grey, gave the number of gorillas, the ferocity of whom has been a particularly tall traveller's tale for a century, as only 100 within the limits of Uganda. It would take too much space to detail the reduction of giraffes and various antelope, such as the Mountain Reedbuck (*Cervicapra fulvorufula*) and the Oribi (particularly *Oribia scoparia*), from the richest abundance either to rarity or the verge of extinction The use of colubus and blue monkey skins by the fur trade has had a like disastrous effect upon their numbers. As elsewhere in the world, the major destruction of the African fauna has been not for agricultural protection but trade exploitation, and, as the Game Ranger, Captain Caldwell, remarked two years ago, "the quickest and most certain way of wiping animals off the face of the earth is to commercialize their trophies." When Mr. Cherry Kearton travelled from Cape Colony to the Congo in 1923, he wrote in his book, "Photographing Wild Life over the World," that "in hundreds of miles" he "did not see half a dozen animals."

We turn to Australia and read Sir James Barrett's concise summing up in 1925 of the status of Australian mammals: "Except in certain places where enlightened citizens have protected them, they are all disappearing. In no other continent has the devastation been more rapid than in Australia." Three millions of their skins were exported to the United States alone in 1924, and the Tasmanian Wolf (*Thylacinus cynocephalus*), of special interest to science as a primitive carnivorous marsupial, is in danger of extirpation. A characteristic victim of the thoroughness of American methods is the Prong-horned Antelope or Prongbuck (*Antilocapra americana*). In this case the destruction was for food. Between the Mississippi and the Pacific coast and from Canada to Mexico, it was calculated that the Prongbuck existed in actually greater numbers than the bison in the day of his glory. Though this antelope's agility is such that it can travel at the speed of almost a mile a minute, the 1927 census revealed his complete tally as only 49,000 head, half of which were in Wyoming alone.

Whether and however far we travel, north and south, east and west, from land to sea, from torrid to frigid zone, from jungle to desert, we are confronted with the same monotonous version in our own enlightened age of the story of the Gorgon's head which turned all it looked upon to stone. It was calculated in 1925 that not more than 250 Musk-Oxen

(*Ovibos moschatus*) had survived the demand for their hides throughout the whole American Arctic where they roam. Modern commence has had no sentimental consideration for an archaic beast who captured the imagination of our palaeolithic forbears. Polar and grizzly bears, once common animals and the material of so many half-legendary tales, will soon have become all legendary indeed, since they have been forced by swift depletion of numbers into the most inaccessible districts of their range. Even more lamentable is the diminution of the sea-mammals, many of whom are only clinging on to life by their claws. The numbers of the fur-seal herds in the Pribilof Islands were estimated at from two to five millions in 1867, and at 132,000 in 1910. Others of the family have not been so fortunate in the drastic protection that has now been accorded them. The Sea-Elephant (*Macrorhinus leoninus*) that once thronged and enlivened the Californian coast has been so persecuted by commercial enterprise that the *Morning Post* in November, 1922, remarked: " How long their diminished hosts will survive depends on the measure of protection accorded them by international legislation." As is well known, the mighty Sperm Whales (*Physeteridae*) are hardly better off.

THE NORTHERN SEA-ELEPHANT.
The sea-elephant that once thronged the Californian coast of America in large numbers has been greatly persecuted. The diminution of sea mammals is even more marked than that of their land relatives. (Photograph by courtesy of the British Museum (Natural History).)

The facts of the pauperizing of the earth by the destruction of wild life are indeed so overwhelming that they may well stand without comment, since no comment can equal much less enhance the significance of the figures. The " spread of civilization " is often quoted as the inevitable cause for this impoverishment, whereas a consultation of the data unmistakably reveals that commerce is the real Angel of Death. I quote here some figures gathered from lots offered in fur sales alone by one firm alone in one month alone (January, 1927): Fox, 40,000; Gazelle, 10,000; Flying Squirrel, 21,000; Wild Cats, 35,000; Marmot, 65,000. Here is another list from another lot offered in the same month: Fox, 30,000; Beaver, 9,500; Bear, 3,200; Ermine, 6,700; Mink, 10,000; Musquash, 46,000; Martin, 13,500. A third lot in the same month: Gazelle, 10,000; Squirrel, 23,000; Monkey, 2,000; Red Fox, 7,500. A fourth list also in the same month: Ringtails, 100,000; Wallaby, 330,000; Australian Opossum, 360,000. I will give selections from two more sales, one on 7th May, 1927, and another on 3rd September, 1927: Skunk, 150,000; Squirrel, 500,000; Fitch, 65,000; White Hare, 10,000; Marmot, 55,000; American Opossum 400,000; Squirrel Tails, 1,500 lb. The autumn list includes 400,000 Squirrel, 50,000 Fox, 36,000 Ermine, 30,000 Sable, 80,000 White Hare, and 100,000 Peshaniki. The variety of animals listed is astonishing.

There could be no reader, however little his sympathies or interests turn towards the animal kingdom, who, in running his eye down these lists, would not feel some shame at the thought of the spectacle modern civilization would present before some extramundane tribunal. Whether his imagination be exercised by the enormity of the bare figures themselves, or by the sufferings of the animals, he cannot but wonder if our stewardship of the earth by right of evolution has been employed to the best ends of that great process. This, above all, is the question that will most concern the kingdom of science. The ferment of mind which was set in motion by the discoveries of Darwin cannot but view with dismay the threat to the further continuance of that process, which an insensitive commerce has brought upon the world. The bare contingency of the close of the Age of Mammals is a matter of such urgency to men of science that it should surely be they rather than the layman, ignorant of the extent or meaning of the disaster involved, who should press for international action at Geneva to conserve the dwindling life of our planet. It is very certain that if the students of evolution do not take quick steps to guard its inheritance and bestir governments from their lethargy, posterity will exclaim, " But what have you left us ? "

Some Problems of Coral Growth.

By Cyril Crossland, M.A., D.Sc., F.Z.S.

Much has still to be discovered about corals. Whether their age is passing, is one of the problems which the author will investigate during a further visit this summer to the coral islands of the Southern Pacific.

THE two main constituents of coral reefs are the "madreporic" corals and the stony seaweeds, the Lithothamnionae. The former are very distinctly animals, the latter quite completely plants; they are neither of them in any way intermediate between the animal and vegetable kingdoms. The corals, though so lowly, are not members of the lowest of the animal groups, while the stony seaweeds belong to the most specialized division of the algae, the Rhodophyceae or red seaweeds.

The coral polyp may be easily understood by the examination of the sea-anemones so abundant on every coast, and now so well displayed in the aquarium, among others, of the Zoological Gardens in London. The coral polyp differs from the "anemone" only in that the former secretes a little cup-shaped seat for itself, into which it can shrink for shelter, and by which it is raised a little above the rasping of the sand swept to and fro on the sea bottom. The simplest instance is afforded by the little *Caryophyllia* of the south-west coasts of England, in which each anemone has its own cup; from this the large branching or massive corals of the tropics are derivable merely by the multiplication of such limestone cups and by their remaining attached to one another, which is brought about by the power possessed by most corals of vegetative, or *a-sexual*, reproduction. The ordinary sea-anemone will stand almost any amount of mutilation, each fragment afterwards growing again into a complete animal, and with the corals this has become a regular method of reproduction; a polyp which exceeds the normal size may divide itself into two by a partition, or the base of a polyp that happens to extend over the stone to which it is attached may bear swellings which develop into daughter polyps. In this way a single polyp may multiply into hundreds, all remaining attached to one another and connected by their secreted supports into one mass. This may either be branched like a tree or it may be a solid dome-shaped or cylindrical mass—a stone a few inches in diameter or a rock up to twelve feet, the product of many thousands of polyps which have lived for hundreds of years.

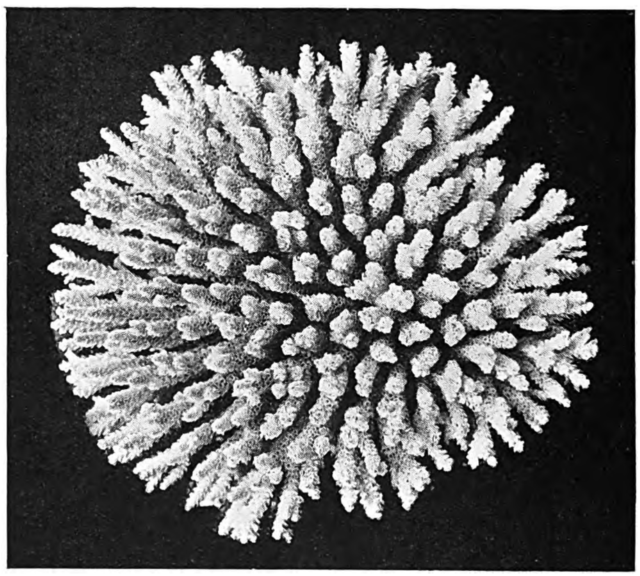


FIG. 1A.
THE NORMAL FORM OF *ACROPORA HYACINTHUS*.
This abundant coral is here seen from above as a large flat disc, bearing upright branchlets. The colonies, often a yard across, are so delicate that great care is needed to take a specimen ashore unbroken. (See also Fig. 1b.)

In this method of reproduction there has been neither egg nor fertilization by the male element, the spermatozoon, but these are nevertheless formed, and by their union give rise to a *sexually* produced larva, which swims and drifts freely in the sea. Should one of these larvae meet with a suitable place for fixation it becomes a tiny anemone, at once secretes its stony seat, multiplies rapidly by a-sexual division or budding, and so founds a new colony. Thus the coral has two methods of reproduction.

The plant-like a-sexual reproduction has some remarkable consequences in the forms of growth, and in the survival of corals upon reefs and their recovery from the destruction wrought by violent hurricanes. The latter was experimentally demonstrated in the course of my cultivation of mother-of-pearl shell in the Red Sea, in which a novel form of oyster bed was made by crushing down the coral along the edges of lagoon reefs with heavy road stampers. A mile or two of gravelly surface was thus produced, covered with water from a few inches to three feet deep according to the season, the general level of the Red Sea being higher in winter than in summer. On some parts of these queer beds pearl oyster could be cultivated very successfully, on others the results

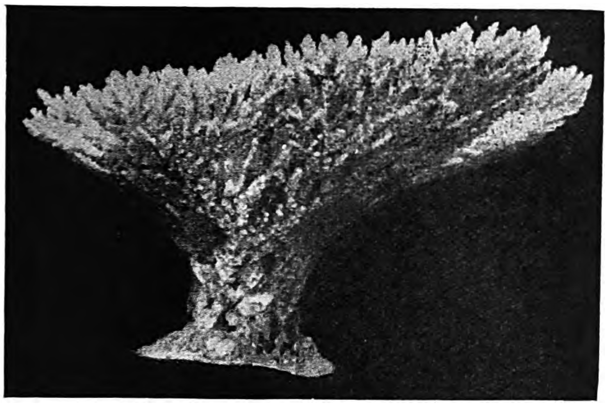


FIG. 1B.
SIDE VIEW OF *ACROPORA HYACINTHUS.*
Similar coral as in Fig. 1a, showing that the colony is supported above the sea bottom by a stalk. Modified forms are illustrated in the other photographs.

were poor. Much of the coral died when thus stamped down and became covered with fungus, the stench of its decay filling the air, but numerous small branches remained alive and continued to grow, sending up vertical branches just as in the case of plant cuttings, so that in two years time the beds were again covered with coral. In all the specimens I examined this new growth of coral arose from the old branches, and none from colonies freshly founded by sexually produced larvae. We had here two rather astonishing results—the vitality of the broken branches, and the absence, or at any rate rarity, of new colonies.

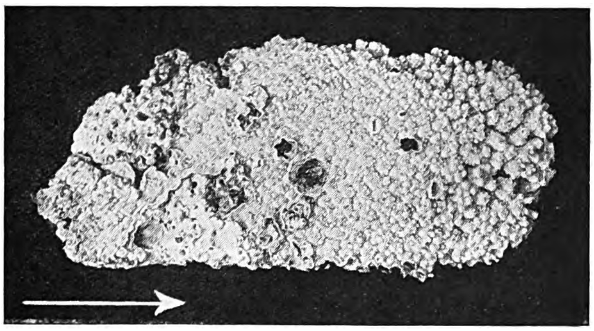


FIG. 2.
SAME SPECIES MODIFIED BY WAVE ACTION.
The same (or closely allied) species has here become a mere slab of solid stone, but it still bears the little branches characteristic of these " bouquet " corals. The arrow indicates the direction of the waves flowing over the reef edge.

This last discovery was not, to me, quite unexpected. In the laboratory it has been found easy to obtain young colonies from the sexually produced larvae of corals, which readily attach themselves to tiles. In order to test this under natural conditions I repeatedly placed tiles among the corals of a rich and undisturbed reef, expecting to obtain a large variety of young corals similar to those species among which the tiles lay. However, after years of exposure, the result was the collection of a few specimens only of one species of *Pocillopora* ; none of the larvae of the many other species with which they were surrounded had been able to attach themselves. An exactly similar result was found with some pearl oysters which were laid near-by for years, although the shells were expected to afford ideal settling areas for the coral larvae. It is true that pearl shells with attached corals are common enough, both in the Red Sea and in the Tuamotu Atolls of the Pacific—a curio shop in Tahiti, for instance, contains examples bearing fine colonies of *Acropora, Porites, Pocillopora,* and others ; but considering the immense numbers of shells fished the rarity of such growths is most marked. Shells from the Red Sea beds did not bear corals in more than one case in several thousand. All this seems to indicate that the great crisis in the life-history of a coral is the attachment of the larva and the growth of the first polyps ; the foundation of a new colony is a rare and difficult event, but once established and well supported above the bottom, the battle is won, the vitality of the colony making it safe for many years whatever mechanical injury it may suffer. Much the same applies to the large mother-of-pearl " oyster." Hence the foundation of a new coral reef, or the recovery of one which has been killed by the mud and fresh water of an exceptional flood, may be very slow, whereas recovery from the mechanical damage of a hurricane may be immediate. Such a flood catastrophe overtook the lagoon reefs of the south coast of Tahiti during my previous visit,* and it is my hope this summer to record the stages of recovery as formerly I recorded those of death. Contrary to

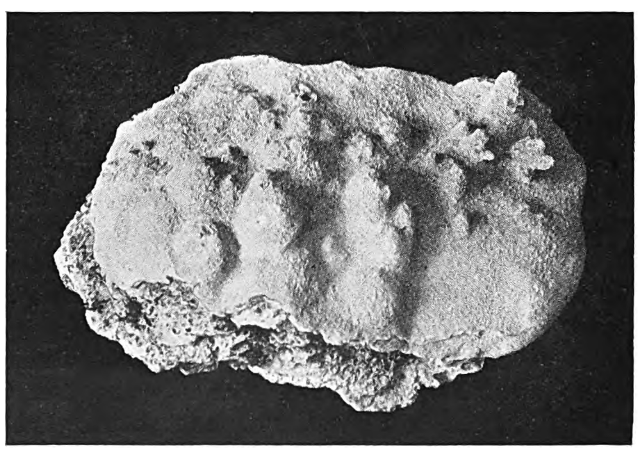


FIG. 3.
ANOTHER STALKED *ACROPORA.*
In this specimen, even the vertical branchlets are practically suppressed, showing extreme adaptation to environment. It now looks like a rounded *Porites.*

* Described in *Discovery*, July, 1927. " Exploring the Coral Reefs of Tahiti." C. S. Crossland.

expectation, all the species of corals did not die at the same time, while some species which seemed unaffected at the time succumbed a week or two later.

Changes of form of one and the same species of coral under different physical conditions in the Cocos Keeling Atoll have been described by Professor Wood Jones, whose account I am able to amplify somewhat from my observations in Tahiti. As already described in *Discovery*, the most abundant corals of the outer reefs are the stalked species of *Acropora* (*Madrepora*). Exposed to the surf, which often breaks with tremendous force, these delicate forms would be smashed to pieces immediately, but they have adapted themselves vegetatively to a form in which they can withstand the terrific pounding of the waves and the wild floods of water poured over them into the lagoon. The stalk disappears, the interlacing branches coalesce into a solid mass, and the upright branchlets become still shorter or disappear altogether; the coral bouquet found in deep or sheltered water thus becomes a mere slab of stone, with no resemblance to the normal form, except in occasional detail. The comparison is shown in the three accompanying photographs. Fig. 1 is the delicate bouquet, which must be handled with great care if it is to be taken ashore unbroken; Fig. 2, a slab with the vertical branchlets just visible; while Fig. 3—a different but similar species—is a rounded mass such as might be formed by a *Porites* instead of being an *Acropora*, a genus so typically branched.

Extreme Changes.

The impact of the waves alone does not cause these astonishing modifications, for only a couple of feet below tide level, where wave motion must be just as violent, apparently normal stalked forms live. When broken across, however, as in the example in Fig. 4, such forms are seen to be highly modified, being thick and solid right to the edge of the disc, and of a denser material than that in Fig. 1. It is clear that the violent and shallow current over the reef edge is the main cause of the alteration of *shape*, and its direction corresponds with the shape of the coral. These are extreme changes in response to violent differences in the conditions under which the animals live, but less marked differences are impressed by minor changes in environment.

It is well known how impossible it is to classify plants by their growth form: leaves, or any set of organs but the flower, are structures so completely subject to environmental changes that they do not indicate the relationship of species. But for the flower, what structure could indicate the close relationship between the red sorrel (*Rumex*) of our hay fields, and a bush in East Africa or a gorgeous pink-flowered creeper common in tropical gardens? The classification of corals is in somewhat the hopeless position in which classification of plants would be without the aid of the flowers. The genera are clear; there is enough constancy in the structure of the coral thecae, etc., to show that certain branched forms are of the same genus as others which grow in solid lumps, or that the loosely branched species of Fig. 5 is but another *Acropora*—the genus to which all the other corals here illustrated belong. But the discrimination of species is so complicated by these vegetative variations as to be nearly impossible. The only hope is that further knowledge of the soft parts, which are not so likely to be affected by external conditions, may provide diagnostic characters that can be more safely applied. Only the beginning of this method has yet been made.

Tahitian Fauna.

The Tahitian coral fauna present other interesting problems. Farthest out in the Pacific Ocean, and the least known of all its many archipelagoes, are the Marquesas Islands. Between these and the Society Islands lies the great archipelago of the Tuamotus, which is made of coral alone, yet the high islands of the Marquesas have no reefs whatever! Many theories, chiefly geological, have been put forward to explain this anomaly, but the problem is mainly one for the biologist, as it was found* that the coral fauna is extraordinarily restricted, careful collecting giving only five genera of corals with about twelve species. By comparison the fauna of Tahiti at first sight seems to be as rich as that of other coral seas, but soon the absence of many old friends becomes striking. Where are all the Astreans, the solid dome-shaped corals of which we expect to see many masses several feet in diameter on every reef, and their allies the "brain corals"? And why is there no *Galaxea*, which consist of great masses of stone quite hidden under thousands of the long green tentacles of its polyps? As *Pocillopora* is abundant, it is strange to see nothing of its nearest allies *Stylophora* and *Seriatopora*; while *Mussa*, which makes masses six to twelve feet in diameter everywhere in the Red Sea, with its great calyces and big velvety brown polyps, is another form that is almost entirely absent from Tahiti.

This restriction of the coral fauna is usually explained as due to the isolation of the islands so far out into the ocean, which, with the fact that the general oceanic circulation is from east to west, makes

* On the voyage of the "St. George." *Discovery*, Vol. VI, p. 423.

it difficult for the floating larvae to reach them. Indeed, it is difficult to see how the larvae arrived which have colonized these shores; certainly none have crossed from South America, the only coasts which lie to windward. The case of *Mussa* seems to indicate that isolation is not the whole story, and that adverse local conditions, of some kind as yet unknown, have had at least as much to do with the matter as any difficulty of the larvae in travelling so far out into the ocean. *Mussa* has arrived, but is unable to grow to its normal size or to establish any number of colonies. The case of other Astreans seems to be the same, since collecting revealed the presence of only ten species; all were insignificant little things, except one specimen which attained the very small maximum size of six inches in diameter. *Stylophora* has arrived; it was found only once in a tiny colony, but it grows to proper size on the Tuamotuan reefs, still further out in the ocean.

It was therefore surprising, in visiting Rarotonga, 630 miles to the south-west of Tahiti, to find the shore strewn with "brain corals" and the other forms so conspicuously absent from Tahiti. As Rarotonga is an older island, conditions are probably better for coral growth, owing to the greatly reduced outflow of alluvium into the sea during floods; Moorea Island is in much the same state, yet it has no coral species not seen in Tahiti. The whole problem of the distribution of corals in the eastern Pacific promises to be most interesting, and its solution will doubtless throw light on general problems, as well as on the foundation, growth, and decay of coral reefs.

In conclusion, is the age of corals passing? Has the fauna around Tahiti always been so poor—were the missing Astreans, for instance, formerly there at the time the reefs were growing up? Geological evidence there is none, and without borings it is

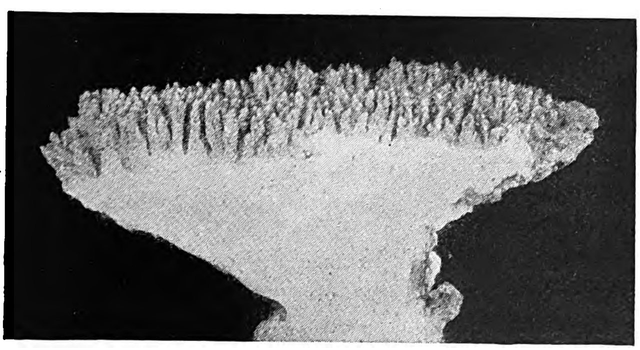


FIG. 4.
SOLID FORM OF NORMALLY DELICATE "BOUQUET."
This grows in about two feet of water on the seaward edge of the reef, and seen from above it resembles the normally delicate form. (It is here broken vertically across the centre.) The great thickening and solidity of the fused branches enables the coral to resist the pounding of the surf.

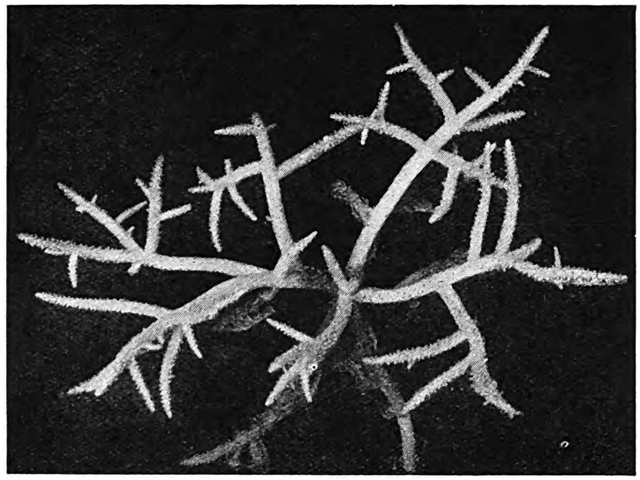


FIG. 5.
"STAG'S HORN" CORAL.
One of the loosely branched "Stag's Horn" corals, which, in spite of the great difference in mode of growth, is merely another species of the large genus *Acropora*.

unattainable, as the only elevated rock is of far too recent origin to answer this question. Even the lower stratum has no species not now living on the Tahitian reefs, though it contains a coral not usually seen in the lagoon.

The cause of this reduction in the vigour of coral growths is not easy to find. It may be biological, concerned with the balance of life, either among the species of corals themselves or between those organisms that build limestone and those that destroy it. Or the cause may be physical, due to some change in the character of the water and its contents. There has certainly been a change in the latter in Tahiti, due to the decay of basalt into laterite, which is so conspicuous as a bright red clay on the hill slopes, and which pours in red streams into the lagoons after rain. This hardly seems to be all, however, for only the very exceptional storm and floods in January, 1926, had any effect upon the lagoon corals, and none upon those outside. Is this phenomenon of the death of coral reefs of local importance only, or is it possibly widespread? Is this, the latest of the ages of corals, passing or past? In 1902 I described how the broad reef of Zanzibar is really nothing but a wave-cut shelf, in the great mass of recently elevated coral that forms the coast of all tropical East Africa. In the Red Sea the reef is formed partly by the planing down of elevated coral and partly by growth, and when the limits of each can be made out, it is found that growth has added but a small proportion, even though coral grows there in astonishing abundance. In reading descriptions of other reefs also, the most striking impression gained is the scarcity of living corals in comparison with the immense structures produced by them in the past.

Modern Advances in Photography.

By T. Thorne Baker, F.Inst.P., F.R.P.S.

The important photographic congress which meets in London this month provides a suitable occasion for reviewing modern advances. In addition to cinematography Mr. Thorne Baker deals with colour work, including a new process designed for amateur use.

The Seventh International Congress of Photography, which is being held at the Imperial College of Science from 8th to 14th July, marks another step in the history of photography. Three years ago the sixth congress was held in Paris, and the occasion was memorable chiefly for two reasons: international agreement was arrived at concerning standardized methods of testing photographic plates for their speed and other qualities, and Dr. S. E. Sheppard announced his discovery of the secret of sensitiveness of silver bromide to light.

It is interesting to look back this year, and to review from a chemical standpoint the great advances that have taken place recently in photography.

The Speed of Plates.

An immense amount of investigation has been carried out since Dr. Sheppard's announcement, as a result of which it is reasonably certain to-day that the fast plates of our time owe their extraordinary light sensitiveness to specks or nuclei of what might be termed foreign substances adsorbed by the grains. When an emulsion is made for a photographic plate it is only slightly sensitive to light until the final ripening process is given—this being a mere digestion or heating of the emulsion. During this brief final process the sensitiveness to light increases many thousands of times, provided always that the original grains have been prepared in suitable fashion. Now this tremendous increase in "rapidity" is only obtained when the silver bromide is suspended in gelatin, and Dr. Sheppard discovered that the minute traces of the sulphur compounds, such as allyl thiocarbamide, thiosinamine, etc., which may be present as impurities in gelatin, become deposited or adsorbed on the surface of the grains during digestion and act as sensitive nuclei. A great deal of work was involved in isolating these compounds from the gelatin, in which they are present perhaps only one part in three millions, and in showing definitely after their identification that their effect on the silver bromide was of such an important nature. Needless to say, a very large number of sulphur compounds have been tried, as well as many other compounds known to be responsible for increasing the sensitivity of the salts.

One cannot say, however, that as a result of these investigations any new plates of miraculous speed have been produced. Nevertheless, plates *have* been produced during the last few months by English firms which are in one case twice the speed of anything hitherto made, and in the other case of enormously increased colour sensitivity. New vistas are opened up by such plates for the astronomers, and this new material has already produced in their hands highly important results.

There are at least six directions in which marked photographic advances are being made to-day.

(1) Cinematography is undergoing a gradual but radical change. The introduction of commercial photo-electric cells has paved the way for the talking film, and whether this new achievement be actually regarded as an advance or as a nuisance, the talking film has certainly come to stay. The sound is recorded on the cinematograph film by photographing a band of light, the width or intensity of which is controlled by the movements of a galvanometer coupled up with the microphone. When the film is projected, the variations in light intensity of a special beam passed through the developed band on the film are used to set up correspondingly varying currents in a photo-electric cell, which after amplification actuate the loud speaker. The talking film is being perfected with surprising success, and it will without doubt play a prominent part in the picture theatres of the future.

Colour Cinematography.

Combined with the reproduction of music and the voice will be the natural colours of the original subject. During the last two or three years, different processes of colour cinematography have been brought, if not to perfection, to a stage where they can add considerably to the charm of the picture. Other processes of colour reproduction, although they have not so far been put before the public, have nevertheless arrived at a state bordering on maturity, and may be expected to be in evidence in the near future.

Cinematography has also made its appeal to amateur photographers, many thousands of whom

to-day take their own motion pictures, and can experience the pleasure of preserving their pictorial records in animated form. This new amateur art is developing with surprising rapidity, and has definitely taken its place amongst the hobbies of ordinary people. The amateur has only to turn the handle of the camera, or to press the button of the spring motor, and to direct his lens upon the subject. The ciné-film, daylight loaded and unloaded, is sent to the makers, and is developed and reversed into a positive for him within a few hours.

(2) Another advance for which perhaps this year will be remembered is the practical progress that has been made in the manufacture of "non-flam" film. Cellulose acetate can be cast as a transparent base for photographic films in place of cellulose nitrate (celluloïd), and it possesses the important feature that it will burn either with difficulty or not at all. The importance of a non-inflammable film is easily recognized when it is remembered that the cinematograph is not only becoming used as a home instrument, but as a powerful aid to education, and that it is being quite extensively employed for business demonstrations.

X-ray Developments.

(3) Progress in the field of metallurgy, as well as in many problems relating to atomic structure, has been pronounced. Photography of the X-ray spectrum is receiving an immense amount of attention from investigators, and crystal analysis is becoming widely employed in metallurgical laboratories. The expansion of medical X-ray work is, from the public point of view, the most spectacular. The majority of hospitals of any size are equipped with powerful apparatus with which almost any type of diagnosis can be assisted. Some idea of the great power of modern installations—with which exposures through the body can be taken in a fiftieth or a hundredth of a second—may be gathered from the fact that high tension transformers, which excite the X-ray tube, have been made recently of as high power as forty kilowatts. A few years ago the use of bismuth and barium "meals" proved of great value in enabling photographs of the stomach and alimentary track to be procured. Recent technique has enabled us with the aid of solutions of salts of high molecular weight to photograph many other organs of the body hitherto impossible to diagnose by the rays. Immense sums have been spent on some of the equipments at the newer hospitals, and the first chair of radiology has been established at Edinburgh. It may be interesting to mention that at one London hospital post-mortem photographs are being taken of the complete body.

The importance of X-ray photography and radiology in general, may be gathered from the fact that this year an international congress, devoted entirely to the subject, is being held at Stockholm. Accommodation has been found for the meetings in the parliament buildings, and the lively interest evinced by this country of prodigious scientific attainment is well shown by the kindness of the King and Queen of Sweden, who are receiving the members of the congress at the palace.

Panchromatic Films.

(4) Of interest to the amateur photographer is the new material offered in the way of panchromatic film. Film sensitive to all visible colours is now almost universally used for aerial survey—a very thriving branch of modern photography—for most cinematography work, and for a great deal of scientific recording. Its merits in the way of truthful tone rendering have been long appreciated by photographers, but it is only this year that panchromatic roll films for the ordinary amateur have become available. Another form of photographic material which bids fair to become an important rival to the dry plate is the film pack. Six or a dozen films are placed in a flat pack which takes the place of the dark slide, and by merely drawing a paper tab the film just exposed is brought to the back, leaving the one immediately behind it in position for the next exposure. Film packs are becoming widely adopted all over the world, and the introduction after many years of experiment of the Imperial panchromatic pack a few months ago has made it possible to deal with many types of scientific work without the use of glass plates.

A further novelty in the way of colour is a triple roll film with which, in an ordinary snapshot camera, blue, green and red records can be obtained with one exposure for subsequent printing in natural colours. This roll film for colour photography is the outcome of a good deal of intensive work, which has been done during the last few months, in perfecting the somewhat old idea of exposing a blue-sensitive, green-sensitive, and red-sensitive film one behind the other, thus obtaining the three-colour sensation negatives simultaneously. The "red" negative is, of course, exposed *through* the green and the blue negative, and the green negative through the blue. An elegant method of printing has been invented, in which three transparent films are used; these print out as a visible image—one in yellow, one in crimson, and one in blue. The three transparent pictures only require a rinse

after printing, and while wet are brought into contact and squeegeed in register on to a paper support. The colours are surprisingly truthful, and an exhibition of these pictures which was given at the recent Congress of Professional Photography caused lively discussion.

(5) If telegraphy can be called a branch of photographic work, then this science, too, may be said to have added lustre to the photographic brilliance of the year. The telegraphic transmission of photographs has been taken up by many leading newspapers in England, although it must be noted with regret that they are only following in the footsteps of foreign newspapers who had patronized the electrical method of picture transmission a long time previously. Pictures have recently been telegraphed in natural colours, but the quality of black and white reproduction has now reached such a state of perfection that only experts can distinguish the wired results from the original pictures.

A New Printing Process.

(6) The present-day reproduction of photographs by photo-mechanical methods is so good that it is difficult for the layman to keep fully alive to the constant improvements taking place. Nevertheless, in the field of rotary photogravure, offset lithography, and the cheap printing of music and book reprints, progress has been made greatly to the benefit of the general public. One of the most striking of new processes is Pantone, which has made it possible to print the finest reproductions on low grades of paper, thereby opening up new prospects for the better illustration of cheap literature. The half-tone screen negative is printed upon a chromium plated copper or steel plate, sensitized with fish-glue in the usual manner. After the unexposed parts (in between the dots) are etched away, the metal is plated with silver, and without further etching the block is printed with an ink containing a trace of mercury. The mercury instantly amalgamates with the silver and repels the ink, keeping it entirely to the surface of the half-tone dots, however small. The result is that reproductions made with the finest screens can be clearly printed on the coarsest and commonest papers, at a great speed.

In conclusion, some mention must be made of the splendid work done by the members of the British Photographic Research Association under the able leadership of Dr. T. Slater Price, F.R.S. An immense amount of fundamental knowledge concerning photographic chemistry has been established by Dr. Slater Price's able staff, and their researches have done much to help forward the photographic industry, not only in this country, but throughout the world.

Correspondence.

EXCAVATING IN PALESTINE.

To the Editor of DISCOVERY.

SIR,

I was very much interested in the article in your June number entitled "How the Modern Archaeologist Works," particularly in view of the fact that I spent the greater part of one year in the district described. This was immediately before and after the third battle of Gaza, and I can appreciate the very great difficulties the excavators must have in discovering likely sites on which to work, for the speed with which the sand storms obliterate all evidence of former occupation is remarkable.

I well remember, in visiting the villages of Deir-El-Bela, Khan Yunis, Beni-Selis, and Um-Gerar, the suspicious way in which the natives looked upon every form of employment offered to them, and my recollection is that although many of the inhabitants were agreeable enough, some showed by their attitude and actions that petty robbery and preying on caravans was more to their liking than labour.

The best labour we had in Palestine at this time was provided by the Egyptian Labour Corps, the members of which received five piastres a day, serving for three months, and then returning to Egypt for ninety days' interval before joining up again. The remarks made by Lieut.-Commander Trumper as to the sharp eye which had to be kept by the excavators on the working gangs claiming their pay, recalls the fact that the principal use the E.L.C. labourers had for their five piastres was for gambling, and that while many of them went for their ninety days' leave with plenty of money, the rest had nothing to spend when they arrived in Cairo.

I had under my charge for a time some fifteen to twenty wells in the neighbourhood of Gaza, and my recollection of the water obtained from them is that, on the whole, it was sweet and good, a sweetness which we interfered with seriously by the introduction of chlorine as a safeguard against contamination. Those of your readers who may remember chlorinated water in Palestine during General Allenby's operations will agree that while it was detestable for making tea, with whisky it was almost undrinkable. I believe I am right in saying that General Allenby refused to drink chlorinated water at Headquarters Mess.

It was easy to obtain water near the coast by making a shallow depression in the sand, but this water was nearly always brackish and only natives would drink it. Many thousands of camels used to come in to the wells of the villages near the coast after days without water on the desert. Notwithstanding thirst, they would patiently wait their turn in long queues, and if the water (pumped up by the engineers into shallow troughs) was too cold, the camels would wait until instinct told them it had arrived at a temperature which made it safe for them to drink.

It was always a mystery to me how the Bedouin managed to keep their animals alive at all, and the success with which the camels and asses were hidden among the sand dunes of the desert was equally surprising.

Yours faithfully,

EDWARD W. GREGORY,
Capt. (R.A.M.C., T.F., Rtd.).

8 Chepstow Place,
London, W.2.

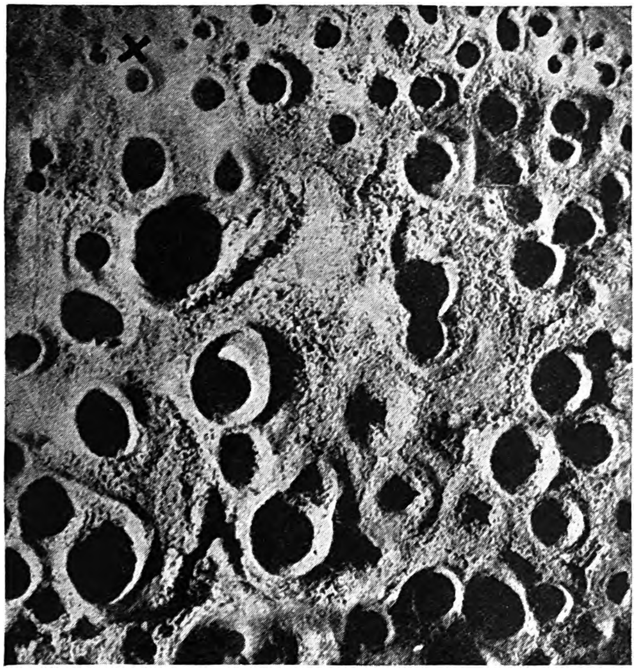
"UNSOLVED PROBLEMS OF THE MOON."

From Professor J. N. Collie, F.R.S.

To the Editor of DISCOVERY.

SIR,

I was much interested in a photograph of the moon you published in this month's *Discovery* (June, page 190); because a few years ago I obtained a series of "craters" in a semi-solid mud, that were very similar in appearance to those on the moon. The one marked X on the accompanying photograph



is almost exactly the same as the one in the left hand top corner of the moon photograph on page 190. The rest also bear a very similar resemblance. The way in which the "craters" were obtained was during the evaporation of alcohol from a compound in a large flask; when nearly all the alcohol had boiled off a semi-solid residue was left. On reducing the pressure by means of a pump, the remaining alcohol in the residue rapidly vapourized in the flask, and produced the "craters" in the semi-solid residue. The result was thought worth while photographing. J. N. COLLIE.

Chemical Laboratories,
University College, London.

MECHANIZATION IN AMERICAN INDUSTRY.

To the Editor of DISCOVERY.

SIR,

Shortly after seeing your article on "Economics and Education in America," published in June, I read with interest a statement by an American authority which largely confirms your views. This dealt with the charge of over-mechanization in industry, and was written by K. H. Condit, secretary of the Princeton Engineering Association.

After remarking that from the purely humanitarian point of view it would be a big step backward to discard the mechanical devices which have largely replaced unnecessary toil, he questions whether many of those who talk of over-mechanization ever did any of the back-breaking jobs which machinery has replaced. With regard to the criticism that machines have killed creative intelligence and made life a horrible monotony, especially in motor-car manufacture, his experiences in a modern assembling plant suggest that this effect is not widespread. Here the cars were coming off the end of a line of machinery at the rate of about one a minute. "It seemed to me," Mr. Condit writes, in the *Princeton Alumni Weekly*, "that there was a whole lot of the game spirit in it. I was particularly amused by the young fellows who drove the assembled cars across the twenty feet of space from the end of the assembly line to the beginning of the final inspection line. The motors were running as these boys slid into their seats, threw in a gear and speeded up across the first seventeen feet, to come to a sliding, wheel-locked stop during the remaining three. I held my breath as the first three did this stunt, but I gathered at last that it was a matter of pride to stop with the glasses in the headlights not more than an inch from the rear of the car ahead. Anyone who left a longer interval was in disgrace.

"I suppose these boys were indulging in a species of 'showing off,' but at any rate they were having a pretty good time. Further back along the line, where there was not the same opportunity to take chances, there seemed to be a general spirit of team play, fostered perhaps by a group bonus system that rewards every member of the team if the group as a whole reaches or exceeds a given standard. I don't know what payment system is in vogue in this plant, but I failed to see any evidence on these men of the deadening effect of their specialized work. They seemed to be perfectly normal as they started for home at five o'clock, with several hours of daylight for gardens or baseball or any other activity that appealed. I could not help but think of the eleven-hour day worked by their grandfathers, before engineers had made their presence felt.

I know that purely political discussion is foreign to the policy of your journal; but as an American who regards the British discovery of his country as essential to friendship and world peace, I think more knowledge of our economic situation can only be of serious scientific value.

Yours faithfully,

Lake Forest, Illinois. DURAND SMITH.

FINGER PRINTS ON PICTURES.

To the Editor of DISCOVERY.

SIR,

In view of Mr. C. E. Hughes's article relating to the identification of pictures, it may interest your readers to know that a new method of uncovering counterfeit paintings of old masters has been advocated by Dr. Hiendl, a German finger-print expert. The *Finger Print Magazine* (Chicago) states that as a result of his investigation in the Munich picture gallery, it was found that the old masters, such as Rembrandt, Titian, Duerer, etc., had left distinct impressions of their finger-prints on the paintings. Those prints which were known to have come from the hand of the master were used as models by which doubtful pictures could be tested.

This method of identification is believed to be faultless for the paintings which have stood in the museums for more than thirty years or before the introduction of the study of finger-prints to Europe. The "rediscoveries" of the last three decades, however, will prove a tougher proposition, for the subject has been carefully studied by counterfeiters.

Yours truly,

Bangor, Carnarvonshire. THOMAS H. PARRY.

The "Death Trap" of Rancho La Brea.

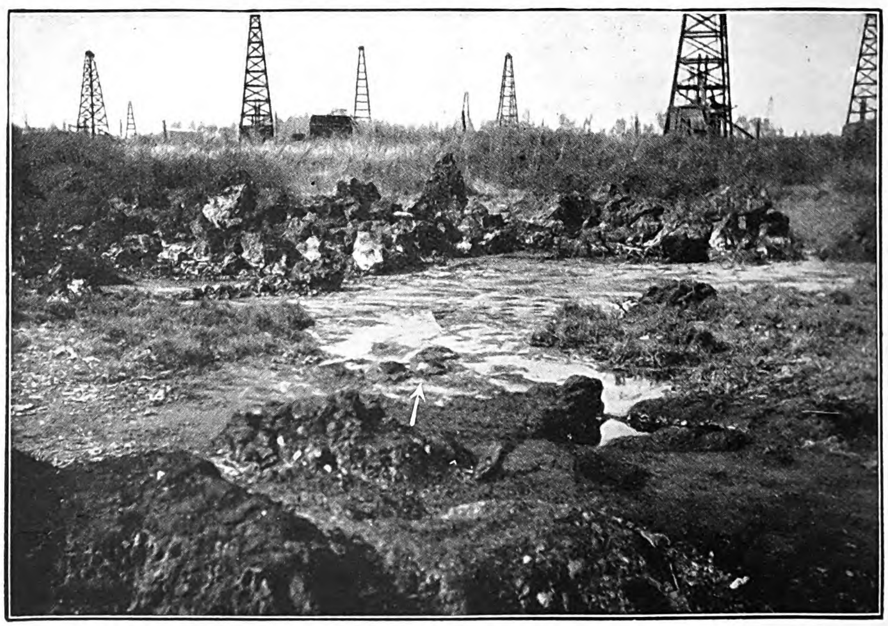
By Robert Zander, Ph.D.

Certain oil wells in California have yielded skeletons of earlier geological periods. The tragic fate of being trapped in the oil is sometimes repeated to-day, and enables us to reconstruct the habits of the ancient animals.

WHILE searching for fossilized plants in the deep coal strata of the lignite mines at Geiseltal recently, I came across some leaves, for all the world as if they had just fallen from beech and willow trees. The importance of the position, and the fact that the geological conditions of the situation were known to me, was assurance enough that one could here go back many thousands of years in the world's history. It then occurred to me whether the processes which have stretched over great periods of the earth's existence could not be demonstrated by experiment? However, one finds that Nature herself experiments enough in these directions. The process of mummifying part of its products goes on daily in the earth, as a certificate of its development, not merely at a slug-like speed, but sometimes with the rapidity of a laboratory experiment.

Viscuous masses of oil well up from the ground which on contact with the air rapidly turn into asphalt; and woe to the animal that is caught through carelessness. It will be held fast despite all its struggles, till it sinks in the relentless oil, there to be conserved for all time. These oil traps are not, of course, very commonly met with, but where they occur, as, for example, in California, not far from Los Angeles, one of the best known petroleum centres, they are frequently found in a series, one after the other. One recognizes them with difficulty because of their general earth grey appearance, but in the early stages they are greasy black and glistening, and reveal that shot-silk effect which we sometimes see on asphalted roads on a rainy day, as a result of fine distribution of oil. Little wonder that animals at play, or hastily fleeing, are caught by such traps in which they are painfully sucked under. And, in spite of his capacity to recognize warning, even man has been often enough exposed to similar dangers in the over-grown bogs which still exist in many places. Stepping unwarily on the grassy surfaces he has been trapped in the bog, to become engulfed and mummified.

American observers in the area where oil patches continually appear afresh, such as that territory known as "Rancho la Brea," have often noticed how animals were caught in the oil, died and decomposed, and sank. The accompanying picture shows such an incident, which occurred in the vicinity of oil-well boring towers. Searching over an old oil source that had hardened into asphalt, observers came across a number of bones which proved to be of a long past period. Thereafter, source after source was inspected with astonishing results. One might say that the earth's diary could be read there. The results of the discoveries are to-day preserved in the Los Angeles Museum. There all is set out, and a thoughtful artist has painted a background suggesting a scene in the days when these bones were clothed with living flesh. But not only the Pleistocene period with its fighting



A CALIFORNIAN OIL POOL.
An oil pool, near Los Angeles, in which a dog was found entrapped. The animal had sunk near the bank at the spot indicated by a white arrow.

sable-toothed tigers, the giant mammals, vultures and mammoths, are revealed by the discoveries, but also clearly enough those times in which, as Heinrich Seidel says, " the mastodon strolled at his ease," and times when bison, puma, lion, cave bears, wolf, fox, and other animals mingled on the earth's surface.

Poetic as this may sound, it is a fact that modern observation and research enables us to obtain a clear picture of animals dead thousands of years ago. From the smallest particle the expert can reconstruct not only a fragmentary part of a past landscape, but he is able to unroll before us kinematographically living scenes. He finds bones revealing fractures which in the far off lifetime of the animal joined together again; malformation and crippling is also discovered, and by anatomical comparison with animals of the present day, he finds these ancestral beasts were of exceptional wildness. From the teeth is learnt whether the animal was carnivorous or vegetarian, if it were a beast of prey or a harmless creature. As conditions are to-day in the animal world, so it must have been in earlier times. When a creature, playing around, landed unconsciously in the asphalt, and in fear of its life cried out, the beast of prey was attracted by the screams in the hope of satisfying its everlasting hunger, unaware that this urge—the strongest impulse in its nature—was drawing it to the grave. This appears to explain why to-day we find such a number of skeleton parts within a small area, so to speak in pockets. And when the bones of primitive birds are found among them, we surmize that the birds were attracted by the insects swarming round the corpses of the animals, and, coming to feed, needed but to stir the surface of the asphalt to be caught and held by their wings in the sticky substance. They died, and to-day men study their cemetery with a curiosity that cannot be satisfied.

A VICTIM OF THE OIL TRAP.
Here a squirrel has been caught in the viscous oil, whose thin asphalt surface has broken under its weight.

Is there still so much to be discovered in the bowels of the earth ? To-day we think we know how it was in the past, but to-morrow may bring forth something which will offer a quite different picture. We see to-day in the oil-pools the decomposed body of a dog, or a squirrel, caught in the tenacious liquid. Putrefaction-loving flies swarm over the decaying corpse ; a bird comes to glut on the insects ; that is the common scene, and we cannot think it was different in earlier times. As the gambolling dog, and the squirrel in his wild flight, fell into the oil-trap, was it not so ages ago ? Not only the wild and high-spirited beast, or one in hasty flight, may meet with disaster ; careful moving cattle can be deceived by the earth-coloured surface and be caught.

The oil areas are certainly not so rich in wild life to-day ; industry and agriculture have driven it away, but in primitive times there was undoubtedly a very wealthy animal kingdom in their vicinity. That amongst these early animals many vegetarians have left their bones for us to study, shows again that the flora also must have been well developed. Around the vegetarians found in the oil-area, the carnivores complete the picture. The imperfectly healed breaks in their mighty jaws show that they had hard work to do at the kill, and the remains taken from the asphalt at Rancho la Brea confirm that the beasts of prey, which are sly and agile, sleep lightly and at the slightest sound are alert—ready to attack or fly in haste—lived exactly as their descendents do in our times. Such numerous injuries are evidence that the fight for life in the animal world is an ancient law of nature. So, after aeons of time, primitive life rises from the grave for our edification.

The New Cruise of the "Carnegie."

By J. P. Ault.
Commander, and Chief of the Scientific Staff.

After an interval of seven years, the American research ship "Carnegie" has again set out on a cruise planned to continue till 1931. The following information is issued by the Carnegie Institution.

CARRYING a party of eight scientists selected by the Carnegie Institution, the non-magnetic yacht *Carnegie* sailed on 1st May from Washington. The vessel has already made six voyages during 1909-1921, covering about 290,000 miles, in a magnetic and electric survey of the oceans. She was specially constructed and equipped for making these investigations, brass and copper being used in her construction instead of iron and steel, and is manned by a crew of seventeen men.

First (Captain Ault writes), we are going to find out what changes have taken place in the magnetic elements over the various ocean areas since the previous cruises of the *Carnegie*. This information is of interest to the student of the earth's magnetism in his study of the many unsolved problems in this science, and it will supply the values needed to keep the navigation charts up to date. These charts are used by the air pilot as well as by the sea pilot.

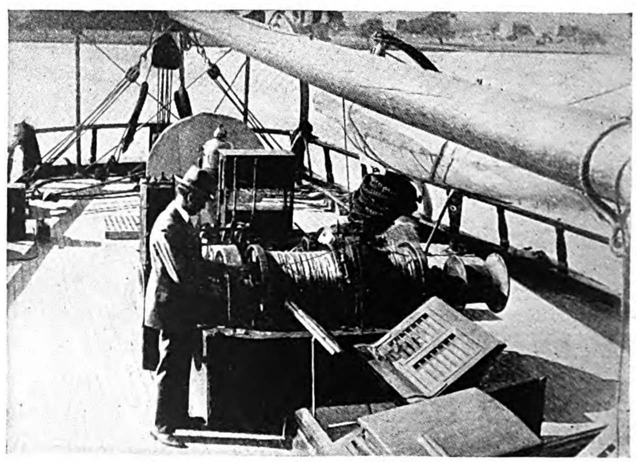
Among these unsolved problems are: the origin of the earth's magnetic field, the causes of the daily and seasonal changes in this field, the close relation between magnetic storms and the occurrence of polar lights and changes in the condition of the sun, and why we have eleven-year periods in magnetic changes and disturbances coincident with the well-known eleven-year periods in sunspot activity. To obtain the maximum of data regarding these changes, it has been planned to retrace to a large extent the tracks of former cruises. The causes of these changes and variations are not yet known, and their explanation constitutes one of the chief problems in the science of terrestrial magnetism.

The second important investigation will consist of a continuation of study of the earth's electric field. The importance of investigations such as this has increased in recent years because of the close relation between variations in atmospheric-electricity and variations in magnetic conditions. Also recent theories regarding the nature of electricity and constitution of matter and the rapid advances made in radio transmission have given added stimulus to these studies. The electric elements which we are to investigate again include the amount of electric charge in the air which increases with height above the earth's surface, being about 100 volts at the height of one metre. There are present in the air at all times both positively and negatively charged particles called ions, about 1,000 of each kind in a cubic centimetre of air, or 16,000 to the cubic inch, and with our instruments it is possible to count the number with fair accuracy.

Intimately connected with the number of ions in the air is its electric conductivity, or its ability to carry an electric current. Whether penetrating radiation, or "cosmic rays," coming into the earth's atmosphere from outer space can be one of the causes of ionization of the air which increases its conductivity is another of the problems to be investigated.

The amount of radio-active materials, such as radium and thorium, present in our atmosphere is collected and measured, this being another source of ionization. These investigations show that, under normal conditions, there is everywhere an electric current passing from the air into the earth. There is not enough of this current, however, to operate anything but a toy motor, and we need never fear electrocution from this cause.

Recent investigations of variations in radio transmission with changing magnetic and electric conditions have led us to install a very complete radio equipment



THE NON-MAGNETIC WINCH.

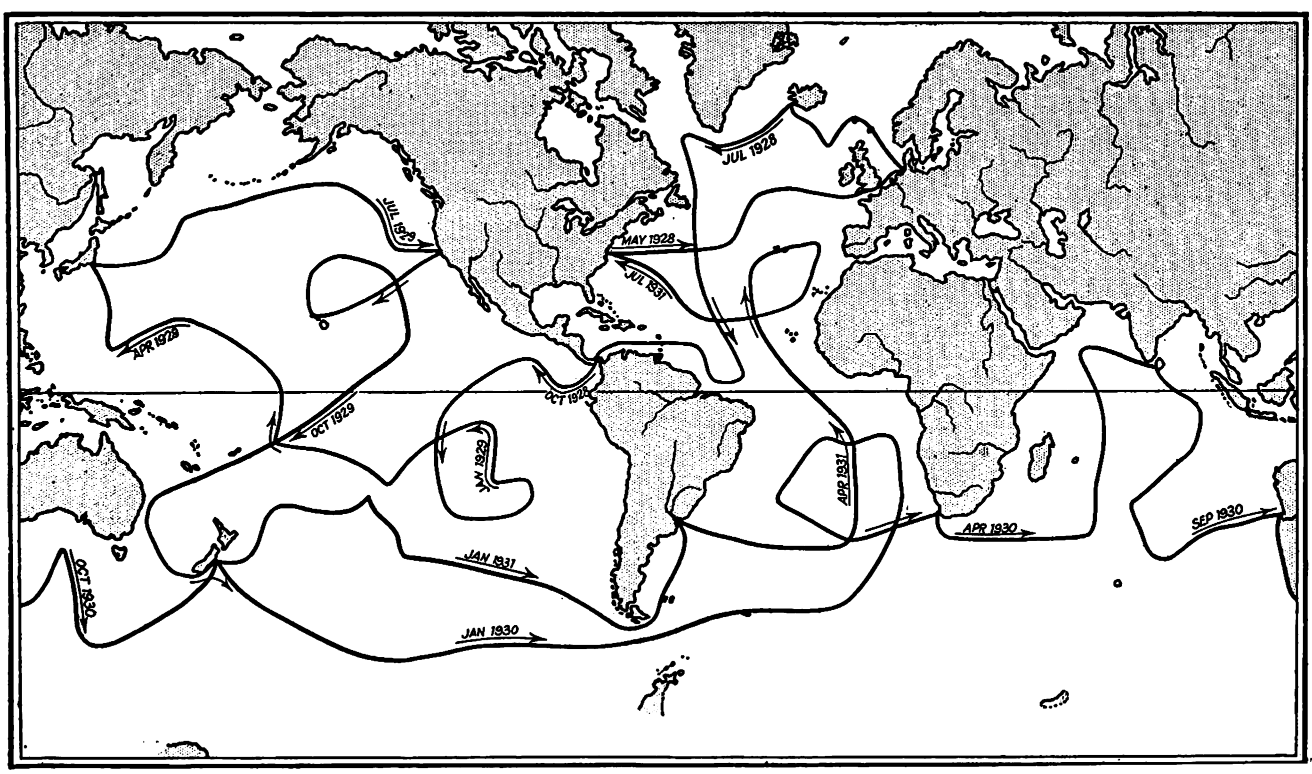
The author is here seen inspecting the electrically-operated winch equipped to reach a depth of four miles. The line, specially made of an aluminium-bronze alloy, is also non-magnetic.

on the *Carnegie* for the first time. Short wave broadcasts will be received during the entire cruise, and a definite programme of transmission and reception is being arranged with the Naval Research Laboratory in Washington. Thus we will carry out experiments and investigations on the important problems of skip-distances and of variations in signal intensity. Time signals will be received daily, thus adding to the accuracy of our time-keeping and consequently to the reliability of our geographical positions at sea.

The mysteries of this vast, practically unknown, expanse of atmosphere above the earth's surface, and of the equally unexplored depths of the ocean, await the pioneering spirit of a Langley or the inventive ingenuity of a Lord Kelvin. When inventive genius makes it possible to investigate the modifications in magnetic and electric variations due to change in altitude, many new and important discoveries will be made.

The third general scientific problem to be investigated is oceanography, and we shall confine our attention to the physical and biological phases of this science. This will be a new field of research for the *Carnegie*. In spite of the considerable amount of information which has been accumulated by the various expeditions since the time of the *Challenger* voyage in 1872 to 1876, we have only a general idea of the contours of the ocean bed, and only a meagre knowledge of the bottom sedimentary deposits which are of peculiar interest in the study of the age and formation of the earth and the changes which time has witnessed. The mapping of the configuration of these great basins covering over two-thirds of the earth's surface should be as important as the mapping of the land masses which occupy less than one-third. Such information will be useful in the study of movements within the earth's crust and of the origin,

THE RESEARCH SHIP "CARNEGIE."



TENTATIVE ROUTE FOR THE SEVENTH CRUISE OF THE "CARNEGIE," 1928-1931.

history, and probable future development of submarine earthquakes. So we have installed one of the recently perfected sonic depth-finders, loaned by the U.S. Navy Department, and we can determine in a few moments the depth of the ocean as the vessel is proceeding on her course. The method consists of measuring very accurately the time it required for a signal sent out from the ship to travel to the bottom of the ocean and the echo to return to the ship again. Sound travels at the rate of about 4,800 feet, a little less than one mile, per second, so that if the time between the signal and the echo is two seconds, the depth is about 4,800 feet.

Four Miles of Wire.

Some corrections to this assumed velocity are necessary on account of varying conditions of temperature and salinity, or salt content of the water, but we expect to measure these variations from time to time at various levels from the surface down to the bottom. We have limited ourselves to four miles of wire only, so the bottom of the sea will be out of reach in some of the greater depths. Approximately six miles is the greatest depth yet measured by wire, the location being near the Philippine Islands.

Water samples and temperatures will be secured by Nansen water-bottles and deep-sea reversing thermometers sent down to various levels, ten bottles being used on the wire at one time. The salinity and chemical content of each water sample will be determined immediately on board the vessel. Changes of temperature and salinity in vast bodies of water cause vertical movements which, combined with other relative movements due to wind and tide, make the ocean with its vast capacity for carrying heat a powerful factor in its influence upon practically every phase of life upon the earth, in its control of climate, and in its determining effect upon man's migration and habitation. Samples of muds and sediments from the bottom will be secured by use of various devices sent down on the end of the sounding wire. One sampler resembles the jaws of a turtle and is sent down open. When it strikes the bottom a spring catch is released and a specimen is snapped up in the jaws.

Perhaps the most fascinating study connected with the sea is the multitudinous life found in all oceanic waters from the surface down to the deepest abyss yet explored. Physical and chemical changes in the ocean waters have profound influences upon marine life, its variety its amount and its distribution. A knowledge of these influences will contribute in many ways not only to the study of evolutionary processes taking place in the sea, but also to the practical problem of economic use of the ocean's food supply. The problems in marine biology are so many and so far-reaching that it has been necessary to confine our attention chiefly to microbiology, to determine the abundance and distribution of the so-called "grass of the sea," the plankton, and other small organisms such as diatoms, copepods, and foraminifera, which ultimately constitute the food supply of fishes and so for our own Friday dinner tables.

Silk tow-nets of various sizes, dip-nets, and water-bottles will be used to collect these organisms. A special double boat boom, called by Beebe a boom walk or glorified pirates' plank, has been rigged so that we can walk out over the water thirty feet from the ship's side, perhaps with more faith than did Peter of old, and there we may dip up surface swimming organisms or operate the surface nets, well away from the disturbing influences of the ship and its motion through the water. A diving helmet is a part of our equipment, so that in warm, clear, tropical waters we may descend thirty to fifty feet below the surface among the fishes, learn how they live, and study and describe the wonders of the under-water world.

Meteorological Problems.

A more extensive programme of investigation in meteorology is being planned, in view of the important influence upon climate of mass movements of large bodies of heat-bearing oceanic waters. The study of the physical interchange of heat and moisture between the surface of the ocean and the air above it is important in the study of atmospheric circulation and the disturbances over the entire surface of the earth because of the fairly normal conditions which exist at sea. Variation in the amount of solar radiation received at the earth's surface, and the influence of such variations upon world-wide weather conditions, have been the subject of much study in recent years. It has been thought worth while to include such observations in our meteorological programme, together with observations of cloud systems, rainfall, evaporation, dust-content and carbonic-acid content of the atmosphere. Increased data of these kinds over the great oceanic areas to be covered during this 110,000 mile cruise of the *Carnegie* may be extremely valuable in the comparison of world weather with solar variation, in the determination of the rate at which the atmosphere is being charged with water vapour so vital to life on the continents, and in the study of the dynamics of atmospheric circulation over the oceans.

Native Magic and Leprosy in Africa.

By Capt. W. Hichens.
Late of the Native Administrative Service, East Africa.

In discussing the campaign against leprosy in Africa which has followed Sir Leonard Rogers' discovery of a cure, the author shows by what means native magic not only hinders the work but helps to spread the disease.

WITCHCRAFT and superstition loom so large in the daily life of the African savage, that science, in offering the native the benefits of her discoveries, often finds herself repulsed and dismayed by the barriers set up by witch-doctors, and by the apathy and fear behind which the kraalsfolk entrench themselves.

What if the white man holds that the plague in the kraal which wiped out a hundred of the clan was caused by the bite of rat-fleas. "*Magu ish* ! Whoever heard of such nonsense ! Has not Mgwek, the medicine-man, declared that the plague was the visitation of demons working the evils of black magic for witch-doctor Ndizigwa, his rival ? If you doubt that, *mala*, you would doubt everything ! For did not Mgwek cast *urogi*, the contra-black-magic of the slow-death, over all the kraalsfolk of Ndizigwa's village, so that they paid in haste a recompense of seventy head of cattle ; whereat Mgwek forgave his rival Ndizigwa and the plague of demons passed away, even as Mgwek had said ?

A NATIVE DRUM DANCE.
At such functions as the native *ngoma* or drum dance illustrated above, often attended by hundreds of natives and by mothers who take their children with them, lepers are frequently to be met, dancing with their friends.

"You say the plague took many victims, while Mgwek was seventy cattle richer for his cunning ! By all the bones of sun-bleached centipedes ! What else would you have ? All men know that the demons of the plague seize victims, and why should Mgwek work his great magic for nothing ? After all, he stood us kraalsfolk a great meat-dance with two roast oxen from the seventy he earned ! As for your white doctor with his talk of rats and fleas—rats and fleas are with us ever ; and if his talk were true then the plague would be with us ever ; but it is not ! "

Such is the logic of the savage, deep ingrained into the superstitious niches of his obscure mind ; and to try to controvert it is one of the most soul-wearying tasks which confronts the worker amongst savage peoples. It is an exasperating, mulish, resistant, passive point of view, and is a main obstacle now standing in the path of one of the finest pieces of pioneering work ever undertaken in East Africa—the campaign against leprosy made possible by the cure discovered by Sir Leonard Rogers and effected by injections of a vegetable oil.

That leprosy is curable Rogers has proved beyond all doubt, and his claim that a cure can be effected in all early cases and in about twenty per cent of advanced cases marks a triumphant epoch in tropical medical research. There are certainly not less than half a million lepers within the British Empire, victims of a disease which, though far less repulsive and infinitely less contagious than is commonly imagined, is nevertheless a scourge whose rigors are too familiar to need description. In British Africa there are, it has been estimated, over 80,000 lepers ; but that figure is unfortunately far below the actual number. It does not, and cannot, take into account many thousands of lepers who live promiscuously amidst their tribesfolk in the kraals of the backveld. In one small tribe numbering about 150,000 natives in a plateau district in Tanganyika, the writer, when administrative officer in charge of the district, accounted for over 400 lepers ; but many cases were concealed from him.

In some cases the lepers were not themselves aware that they were afflicted, for in its early stages leprosy is not always evident to a lay diagnosis. In the majority of cases natives evinced the strongest aversion

to admitting themselves lepers, not because of the ostracism which might be inevitable in the case of a sufferer in a white country, but because they dreaded the prospect of being segregated in isolation camps, away from their wives, children, and relatives, and the amenities of the kraals. In a vast majority of cases dread of witch-doctors prevented sufferers, their relatives and neighbours, and even chiefs and headmen, from disclosing the carefully guarded secret of their affliction. The *arogi* or witch-doctors of this native district, in common with the witch-doctors of many other savage districts in the backblocks of Africa, claimed to be able to afflict any man or woman with the dreaded *nambu*, as they term leprosy, by the machinations of black-magic; and in the eyes of the tribesfolk a leper was one bewitched with this terrible magic. In such terror is this form of black-magic held by the kraalspeople that even the fearful word *nambu* is not spoken by them, the word *matana* (*i.e.*, the "illness") being used in its stead. No tribesman willingly gives information to identify a leper, lest the witch-doctor who worked leper-magic on the sufferer should in vengeance wreak an even more frightful spell upon the informant. The leper himself, confidently believing that he has been bewitched and probably being conscious that some neighbour or relative or enemy had good grounds for working off revenge on him, seeks out a friendly witch-doctor of his own clan. He then pays fees in goats, grain, fowls, beads, axes, and other native money, for a spell of counter-magic which will cure his affliction and at the same time inflict some terrible suffering upon the enemy by whom he has been bewitched.

A Domestic Quarrel.

A typical instance of this magic is provided by a case which came before the writer as a magistrate in a native criminal court in Tanganyika. A youth, one Mkulu bin Pundi, complained that his uncle Nzuri bin Maugila, a wealthy native known to the kraals as a dabbler in black-magic, had unjustly bewitched him with *nambu* with the result that Mkulu developed leprosy in the left knee.

Said Mkulu, "During the famine, when food was scarce, I asked my uncle for permission to work for him by herding his cattle and tending his plantations, my wages to be my food and lodging. I lived with my uncle for a year, and food was then so scarce that my uncle decided to bury his remaining grain supplies in a pit as a precaution against thieves. I went with the young men and the women of his huts and we buried the grain in a pit in the bush. Two days later he drove me from his house because I was too tired to clean out his cow-yard. I had nothing to to eat; there was famine; so I went to the place where we had buried the grain and took some to my hut, where I cooked it and buried the rest in a pit near my hut. In the evening of that day my uncle came to my house and accused me of stealing his grain. I said, 'Yes, I have taken it, but you drove me away, and I had no food, so I took it to eat.'

"On the following day we went before our chief who heard my uncle's charge, and the chief fined me one cow and three goats for theft. I took this fine to my uncle, but he refused to accept it and he said, 'Since you stole my grain in famine time I will destroy you with disease. I am a rich man and do not want your cow and goats; I will destroy your body with disease!' Later a sore appeared on my left leg, and that developed into leprosy. When I went to pay him the cow, I saw one of his women, Mguli, take earth from my footprints to mix with *nambu-dawa*, leprosy-magic-medicine, which is the way of our tribe to give thieves leprosy."

The Witch-doctor's Methods.

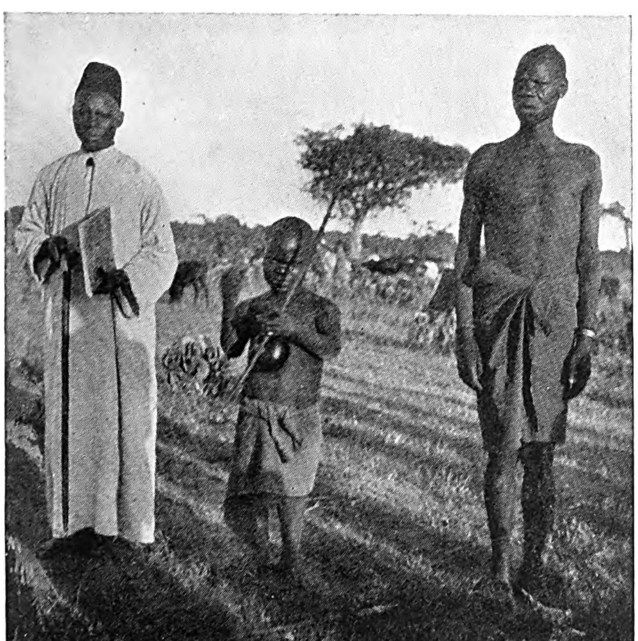
After numerous native witnesses had testified that Mkulu had not shown signs of leprosy before he went to work for his uncle, or before the theft of the grain, the chief of the kraals concerned, under careful cross-examination, divulged with much hesitation the method in which this dreaded magic is worked, and his account, as follows, is quoted from the court file. "I went to a place near Mkulu's hut; there was a pit there, such as is dug for burying grain. The pit was filled with loose earth. I ordered Mkulu to remove the earth. He did so, and disclosed, first, a branch of a thorn bush; under this, a short stick sharpened to a point and standing upright on a stone; under which stone was another short stick. These things are used by the witch-doctors to work *nambu*, to give people leprosy. I did not touch the things. I would not touch them even if the court ordered me to do so; I would prefer imprisonment."

It would be silly, the chief went on to explain, for anyone to think that a mere sharpened stick could give a man leprosy; but, he said, the stick which had stood point upwards on the stone was cut by a witch-doctor from the doorpoles of a leper's house. It would be infectious from continual contact with the leper's hands. And it was so placed on the stone, that a man standing by or kneeling near the grainhole could scarce help but tread or kneel upon its sharp point concealed just beneath the surface of the earth, so that the stick would pierce his foot or

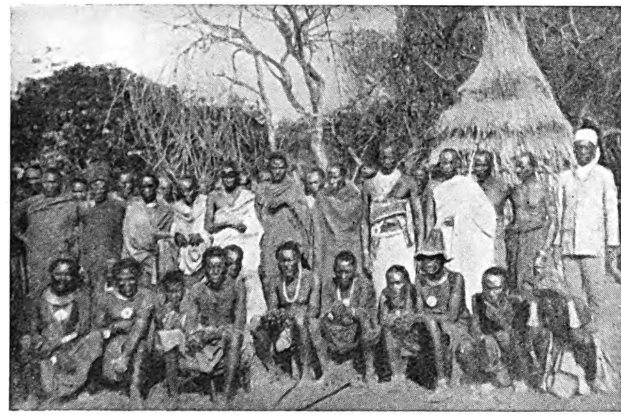
knee and innoculate him, as it were, with *nambu*. The stick under the stone was *urogi* (magic), which the chief did not understand, or would not explain. It was apparently symbolical of *nambu*, for it was of rotten wood, cut from a tree eaten away by white ants, by small white worms or maggots. The stone and the sticks taken from the pit were brought by Mkulu into court. None of the native court officials or orderlies would touch them, and several hundred kraalsfolk who had assembled to hear the unusual case gave these gruesome exhibits a very wide berth.

Far from denying the charge made against him, Mkulu's uncle both admitted and defended it. "I told Mkulu that I would work *nambu*-magic on him," he said, "and the *nambu* sticks now being shown in this court were set in his grainpit on my instructions. For a youth such as Mkulu, who stole food in famine time, what punishment is too great? In the hands of such thieves, I and my wives and children might well have starved to death!"

As emphasizing the implicit faith of the savage in the powers of black-magic to cause leprosy, and the complacence with which the savage leper accepts his fate, it must not be overlooked that Mkulu in bringing his case sought to extract from his uncle a fine in cows and goats for *unjustly* putting leper-magic on him. He was an admitted food-thief, and for that the chief had fined him a cow and goats which his



TYPICAL NATIVE LEPERS.
A headman of a kraal (left), with his register, produces two lepers. The peculiar expression of the man on the right is typical of the disease.



GROUP OF WITCH-DOCTORS.
These witch-doctors (seated) are notorious throughout Tanganyika for the malevolent power which they claim of being able to bewitch people with leprosy.

uncle refused to accept. That refusal irked Mkulu. He regarded leprosy as a minor detail, but being bewitched with it by a relative who ought to have accepted a fine, was an affront. When the writer offered to send Mkulu to hospital with a view to being cured, the youth refused to go. "No," he said, "my uncle should pay me a fine in cows and goats; if he does, I want to stay in my kraal and herd them. With two of the goats' kids I can easily pay another witch-doctor to *toa nambu*, to 'unbewitch' me of my leprosy."

Under different names similar forms of black-magic are rife amongst other savage tribes in East Africa. In one tribe, medicine-men are said to inflict leprosy by smearing with leper mucous thorns growing on a springy kind of sapling. The smeared sapling is tied back, alongside the path to the victim's hut, and a tripline made of cows' hair is so set on the ground that the victim's foot springs the trap; and the sapling swinging across the path catches the man across the chest or back, the thorns slashing his skin. Curious sharp three-pronged thorns are also used, being scattered in the doorway of the victim's hut so that they pierce his toes; while in yet another tribe witch-doctors have been known to creep into their victims' huts at night, while they were sleeping, and smear their lips and other parts of their bodies with a paste in which various *dawas* or magic-medicines obtained from lepers were mixed.

Amongst many tribes it is implicitly believed that the mere touch of a witch-doctor, such as resting his hand on his victim's arm or shoulder, or flicking him with a thumb-nail across the chest or stomach, can inflict leprosy. A leper himself may be paid a fee of goats and be given "magic" power by a witch-doctor to carry out the magic spell.

Thus it comes about that the thousands of lepers living freely in the kraals of Africa's backblocks are regarded as victims of black-magic, and are treated rather with pity and sympathy than with apprehension. There can be scarcely a native kraal in the hinterland of East Africa to-day where lepers are not mingling with the healthy kraalsfolk—sitting with them around and eating out of the same cooking pots; drawing their water and drinking at the same wells and water holes; joining shoulder to shoulder with them in their dances; sitting with them in the crowds at their native bazaars or courts and tribal gatherings, and intermarrying with their healthy kinsfolk. It is common to find a male leper married to a healthy native girl, or to see a leper mother nursing her child, a jolly laughing piccaninny, whose glossy brown skin, satin-like and flawless, testifies to its freedom from the scourge.

On its neck or its wrist the child will wear an *irizi*, a talisman bought from a witch-doctor, and with that protection from black-magic, the evil-eye, and other forms of bedevilment, its stricken mother is unwaveringly confident that the child cannot fall victim to the dreaded *nambu*, unless by ill-fate some evil-intentioned person, with a more potent charm, overcomes the power of the *irizi* and bewitches the child. The witch-doctors who practice *nambu*-magic naturally bolster their tribesfolks' faith in its terrors, for they derive a rich harvest from it, in fees of goats, grain and other commodities. In addition, the more people they "bewitch" with leprosy the greater the notoriety they achieve and the stronger the hold they gain upon their credulous and fearbound tribesmen. In the face of such beliefs, it will readily be seen how difficult it is to persuade native lepers to submit to treatment and to the inconveniences of segregation.

Leper Camps.

With the funds for the entire anti-leprosy campaign throughout Africa amounting to less than many spendthrift borough councils in England are frittering away in doles, it is impossible for private enterprise to provide either adequate medical or nursing staff or to build suitable *lazarettos* and hospitals for the lepers of the backveld.

The best backveld leper camp can only hope to be a cluster of mud-walled, grass-thatched huts built in the isolation of the bush. To provide adequate guards to prevent lepers deserting such camps, is not yet possible. Wives, children, and relatives visit the camps and often take up permanent residence with their afflicted kin, and, although leprosy is not so contagious as imagined—the writer was an official visitor to a leper camp for many months with no greater precaution than a fly-whisk—the scourge is spread from kraal to kraal, unchecked.

The difficulties which must be surmounted by the medical pioneers who are working amongst these savage peoples can be imagined. There are, as Sir Leonard Rogers has recently announced, sixty-two British men and women doctors administering his cure in British Africa, and during the past few months 100,000 doses of the cure have been sent out. It is aimed to increase the number of stations at which the cure can be distributed, and also to plant hydnocarpus trees, from which the curative oil is derived, in districts where leprosy prevails. So is marked a new epoch in British efforts to ameliorate the lot of the suffering thousands who are victims of what the savage looks upon as the black-magic of *nambu*—that terrible scourge, nigh as baleful as the native superstitions which surround it, and which can be conquered, not by gun or rhino-whip, but only by that greater magic, the untiring zeal of the white pioneer.

The Home University Library.

EVERYONE will be gratified that the Home University Library has been given a new lease of life, and the first volumes to be added since Messrs. Thornton Butterworth took over the series in every way maintain the former standards. New titles are to be issued yearly, and recent additions to the science section include "Sunshine and Health," by Dr. Ronald Macfie; "Birds," by Dr. Landsborough Thomson; and "Insects," by Professor Balfour Browne.

Among the new literary titles, Mr. J. R. M. Butler's "History of England 1815-1918" is of outstanding interest. The hundred years between the Great War which we all remember, and the last great war before it, must always rank among the cardinal periods of English history, for it changed the face and outlook of England as no previous century had changed them. Besides the industrial revolution and the birth of modern science, Mr. Butler reminds us of a factor of no less significance, which is not always given its true value. The religious revival connected with the names of Wesley and Whitefield was less spectacular than the economic and political movements, but it was an impulse which gave a new source of thought and action to many thousands of men and women, enabling them to endure without despair the hardships of an age of transition. At the present time, when intellectual thought is again passing through a state of flux following another war, it is well to be reminded of a great moral force which sustained our forefathers in a similar period.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

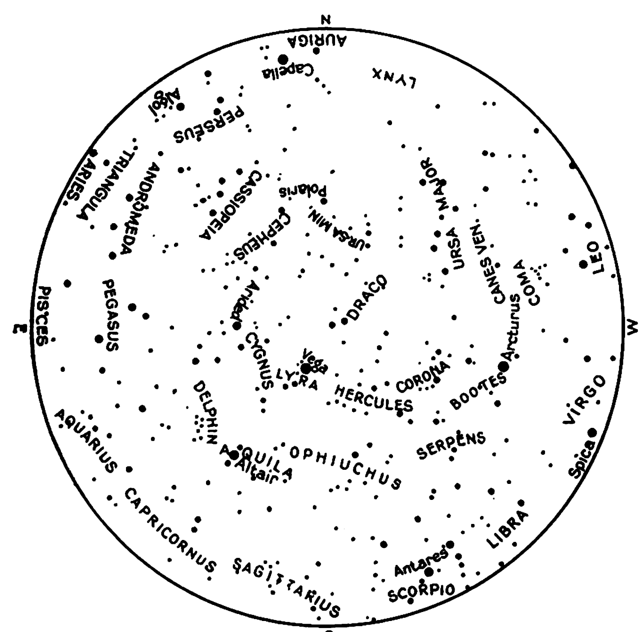
Nova Pictoris.

DR. SPENCER JONES, His Majesty's Astronomer at the Cape, is now in England, and gave the latest information about Nova Pictoris at the June meeting of the R.A.S. It is now thought that the large rings, some 3 minutes in diameter, round the star are not real, but arise from the star's colour being red, so that its image is somewhat out of focus; similar rings have been seen round other red stars on photographs. The much smaller oval nebulous patch, some 1½ seconds in diameter, round the star is real; it contains four condensations, whose positions may be described as follows. Draw an inverted equilateral triangle; the brightest condensation is at its centre of gravity, the faintest at its lower angular point, while the other two are slightly below the upper angular points. The faintest one was a very difficult object, only rarely seen, but the others were not difficult. The further development of these condensations will be very interesting. Fortunately the star, being a long way from the path of the sun, can be seen at some time of the night throughout the year, so the watch on it can be continuous.

Planetary Photography.

Prof. W. H. Wright delivered the "George Darwin" lecture at the R.A.S. last month, choosing planetary photography as his subject. His photographs of Mars with infra-red light show the surface markings very strongly, while those in ultra-violet light hardly show them at all, but show patches of cloud or mist in the upper regions of the planet's atmosphere. Similarly, terrestrial photographs of distant landscapes in red light show detail, while those in violet light are veiled by a general mist. The familiar fact that the setting sun looks red arises from a similar cause; the shorter wave-lengths cannot penetrate a thick layer of air. The conclusion as regards Mars is that it, like the earth, must have an atmosphere of appreciable density and considerable absorptive power. This fact, combined with the radiometric measures of Lampland, Coblentz, and others, which indicate a summer temperature of the planet's surface far above freezing point, are in favour of its possible habitability. In fact, most Martian observers consider that the changes of tint of the bluish-green regions can best be explained by the seasonal changes of some kind of vegetation; and where there is vegetable life it appears likely that it is accompanied by at least low forms of animal life.

The photographs of Venus, unlike those of Mars, showed no detail at all on the infra-red plates, but did show some markings on the ultra-violet ones. These markings must be in the upper regions of the planet's atmosphere, and there seems to be some hope that repeated photographs of the kind may help to solve the problem of the planet's rotation; the solid body, however, might be rotating at a different rate from the upper regions of the atmosphere. The absence of detail from the infra-red pictures may mean either that these only reach a lower cloud layer, or, if they reach the actual surface, that it is uniform throughout, for example, a water surface.



THE HEAVENS AS SEEN FROM LONDON at 18 h. sidereal, that is, at 11 p.m. (12 p.m. summer time), on 7th July, and 10 p.m. (11 p.m. summer time), on 21st July. Saturn is now well placed for observation, a few degrees high left of Antares.

Scope for the Cinema.

The photographs of Jupiter in ultra-violet light are distinctly larger than those in infra-red, showing that they portray a higher region in the atmosphere. But in the main the system of belts appears the same in both sets of photographs, showing that the belts extend to a great depth. Prof. Wright exhibited a very interesting series of cinematograph pictures of Jupiter; these were taken at intervals of a few minutes, but were run through the lantern at a more rapid rate, so that one saw the planet rotating and could observe its whole surface in a short time. A satellite crossed the disc during the exposures, appearing bright near the edge of the disc, and dark near the centre; its shadow was dark throughout. These photographs clearly showed that the cinematograph has many possibilities in astronomy, not merely for popular exposition but also for research.

The International Astronomical Union.

The third triennial meeting of this body will be held this month at Leiden, and will be attended by astronomers of almost every country. The aim of the meetings is to co-ordinate work and prevent unnecessary overlapping. The best methods of attacking problems are discussed, and observers have fields of work suggested to them. The Union has already been of help in accelerating the publication of the remaining zones of the great photographic star catalogue, and the end of this work —it was begun about forty years ago—is at last in sight. Plans are being drawn up for making the utmost use of the near approach of Eros to the earth in January, 1931, to study the size, shape, and colour of the planet, in addition to its parallax.

One of the sections of the Union, that of meteors, is specially suited for amateurs, since no instruments are needed, though cameras with rapid lenses are very useful for active showers; Prof. Lindemann and Mr. Dobson have obtained valuable information about the upper air by a photographic study of meteor trails.

Book Reviews.

The Conquest of Mexico. By BERNAL DIAZ DE CASTILLO, 1517-1521. Edited and translated from the Spanish by PROFESSOR A. P. MAUDSLAY. (Routledge. 15*s*.).

The Silver Cities of the Yucatan have exercised upon archaeologists and others a fascination which has not dimmed in the four hundred years which have succeeded the Conquest of Mexico by Cortés. And Bernal Diaz's account of the exploits of the Conquistadors, here admirably reproduced and edited in the Broadway Travellers' Series, goes far to tell us why. Professor A. P. Maudslay, moreover, who is Professor of Archaeology at the National Museum, Mexico, is not only fortunate in his publishers for, for the purposes of making his translation he has had access to the exact and only complete copy of the original Diaz manuscript which has never left Guatemala, and which is now preserved in the Guatemalan archives. This is far from saying that his task has been an easy one. Whatever else Cortés's faithful lieutenant may have been, except when moved, he was no born writer, and it is therefore all the more to his translator's credit that we are not reminded more often that we are of our school-days—our Anabasis—and that wearisome reiteration of so many *parasangs* per day.

But putting narrative skill on one side, what an absorbing story this bluff old warrior gives! Young and impecunious at the time of the events which he narrates, he himself was frankly after fame and fortune, yet very soon, as he is honest enough to record, he was wondering how far the game was worth the candle. "So great was our thirst that our mouths and tongues were cracked with dryness and there was nothing to give us relief. Oh! What hardships one endures in discovering new lands in the way we set out to do it; no one can appreciate the excessive hardships who has not passed through them as we did." A hazardous business, it seems, this plunging of a mere handful of Spaniards into the unknown against a powerful and warlike race, and yet one which he felt, on the other hand, held its compensatory rewards. For, apart from material gain—though nothing is more to the discredit of Cortés than the way he cheated the common soldiers of treasure trove—fair Indians became fair game; "to every man a damsel or two" the order of the day. And with delicious irony they had all, first of all, to be baptized! Christianity and Conquest were at all times to go hand in hand.

It is in this story of religious zeal and fanaticism, and in his descriptions of the Maya gruesome heathen rites, that Diaz is at his best. Cortés has often been accused of being cruel on enforcing Christianity upon his conquered foes, and in employing such methods as he did, but his cruelty pales beside the orgy of human sacrifice which existed in its place. To Cortés, like Cromwell, not only was the smashing of idols but in accordance with the will of God but, unlike Cromwell, the Spaniards had always before them the awful fate which awaited any of their comrades who might fall into the enemy's hands. Here is one such occasion which the author gives us to understand he witnessed from a distance: "When they got them up to a small square in front of the oratory, where their accused idols are kept, we saw them place plumes on the heads of many of them and with things like fans in their hands they forced them to dance before Huichibobos, and after they had danced they immediately placed them on their backs on some rather narrow stones which had been prepared as places for sacrifice, and with stone knives they sawed open their chests, and drew out their palpitating hearts and offered them to the idols that were there, and they kicked the bodies down the steps, and the Indian butchers who were waiting below cut off the arms and feet and flayed the skin off the faces, and prepared it afterwards like glove leather with the beards on, and kept those for the festivals when they celebrated drunken orgies, and the flesh they ate in *chimole*."

That the hand of God was with them is, indeed, quaintly expressed throughout. On one of the many occasions when Bernal was wounded he tells us about it like this: "Many Indians had already laid hold of me, but I managed to get my arm free and our Lord Jesus Christ gave me strength so that by some good sword thrusts I saved myself, but I was badly wounded in one arm." The concluding stages of the siege of Mexico City—a siege which lasted eighty-five days, and which involved the most stoic courage and endurance on the part of the defenders—are thus described: "Guatemoc and his captains were captured on the thirteenth day of August at the time of vespers on the day of Señor San Hipolito, in the year one thousand five hundred and twenty-one, thanks to our Lord Jesus Christ and our Lady the Virgin Santa Maria, His Blessed Mother, Amen." It must all have been so very satisfactory. Complacent, never; but perhaps we cannot wonder if consistent Divine approval makes our author here and there seem at times a little vain.

H. A. J. WILDER.

Biological Chemistry and Physics of Sea Water. By H. W. HARVEY. (Cambridge University Press. 10s. 6d.).

An Introduction to Oceanography. By J. JOHNSTONE. Second Edition. (The University Press of Liverpool Ltd. 15s.).

During the last twenty-five years the science of oceanography has progressed enormously, and includes so much that a general textbook is practically an impossibility. These two volumes are therefore specially welcome, dealing as they do with two quite different aspects of the subject. That one of them has already reached a second edition is ample proof that such books are wanted.

Mr. H. W. Harvey's "Biological Chemistry and Physics of Sea Water" treats of a still more modern side of physical oceanography where there was an obvious need for a work which should bring together all the valuable information, so much scattered, which existed on the subject. Mr. Harvey has accomplished his task with conspicuous success, and all his work tends to show the relationship of the chemistry and physics of the sea to the living creatures in it and the importance of studying the life in the sea in relation to its environment. His sympathy with "all those cold-blooded animals who live in the sea," to whom he dedicates his book, is very apparent, and marine biologists and physiologists will be grateful for much help. Already both botanists and zoologists are paying more and more attention to the chemical and physical factors which affect all marine organisms, and here they are aided in every way possible. All fisheries questions have, of course, to do fundamentally with a minute knowledge of the sea—chemistry, water movements, temperature, etc., and the biologist as he progresses in the solving of his fisheries problems finds himself more and more dependent on the hydrographer. The present volume has ever these problems in view, and based as it is on the newest methods, much of which originated from the author's own work, or from that of other workers at the Plymouth Marine

Biological Laboratory, it is, and will be for some time, the standard book on the subject.

Professor Johnstone, treating his subject from an entirely different standpoint, deals chiefly with the geographical and the geophysical aspect. As he himself says, it is with the outlook of the student of geography and geology that the book has been written. He has improved it very much, having rewritten a large part of it, and although he includes chapters on the chemical and physical characters of sea water, the greater part is occupied with discussions on the origin of the earth and its oceans, the character of the sea bottom and the coasts, the tides and the oceanic circulation. Some prominence is now given to the influence of radio-active substances in the earth's crust with reference to its age. With regard to the permanence of ocean beds the view is taken that there is no satisfactory evidence in favour of their elevation to form new continental land regions, but that there is evidence that former continental lands have undergone depression and are now deep ocean beds. The statement on page 338 that "wherever there are now sedimentary rocks there must have been sea in the past" is rather sweeping. Are we not to take into consideration any fresh water deposits? The whole question of secular changes in the ocean dealt with in the last chapter is extremely interesting, the following conclusions being emphasized: "Great land areas have probably disappeared and been replaced by ocean," but "there is no good evidence that ocean floors have ever become dry land" and "It is highly probable that the volume of the ocean has increased throughout geological time."

Possessed of these two books, the student will have a very good idea of most of the questions involved in modern oceanography, and will almost certainly be stimulated to continue investigations in one or more of its branches.

M. V. LEBOUR.

Propaganda Technique in the Great War. By HAROLD D. LASSWELL. (Kegan Paul. 10s. 6d.).

For good or for ill propaganda obviously plays a most important part in modern life. It is popularly supposed to be somewhere near the basis of the greatest commercial successes, and both in war and in peace it exercises a profound influence upon the course of international relationships. As everybody knows, during the late war the organization of propaganda was developed to the extent of becoming an enormous practical art. Every important belligerent nation made use of this weapon, and was more or less convinced of its efficacy. Consequently Dr. Lasswell's study, which is the first comprehensive, detailed, and critical treatment of war propaganda based upon the records of 1914-1918 to appear, is to be warmly welcomed.

Propaganda is defined by Professor Lasswell as the control of public opinion by significant symbols, that is, by stories, reports, rumours, and other forms of social communication. He shows in detail, and with abundant illustration, that its use is conditioned by: traditional prejudice, the network of communication between the peoples concerned, and the general state of irritability or unrest characterizing the community (he calls this the "tension level of the group"). He describes the actual methods of propaganda organization adopted during the war by England, America, France and Germany, suggesting in a most interesting way that the differences of method connect up with important racial and national differences. He treats the aims of propaganda as four in number: to mobilize hatred against the enemy, to preserve the friendship of allies, to influence neutrals, and to demoralize the enemy. He recounts the varying methods adopted to bring home these aims to different sections of a population, making some particularly apposite remarks about the relation of propaganda to truth. Finally, he briefly assesses the results of propaganda, which he believes in this instance to have been very considerable.

The whole book is extremely interesting and worth reading. That it is not written from a psychological point of view is probably all the better. We get facts rather than theories. Yet in some respects the author might with advantage get a bit nearer inside the minds and attitudes of the propagandist, official and unofficial. There is a too strongly developed tendency to regard him as the clever wire-puller, jerking about the puppet members of the ordinary social group, but knowing all the time that he is really at play. It is difficult now to realize the honesty with which nearly all the stories which Dr. Lasswell records were developed and passed from mouth to mouth during the war. But the fact was so, and both propagandist and his audience were the outcome of a social situation which they, in their turn, shaped to new ends.

A very useful bibliography is included in this book.

F. C. BARTLETT.

The Basis of Sensation. By E. D. ADRIAN, M.D., F.R.S., Fellow of Trinity College, Cambridge. (Christopher's. 7s. 6d.).

The events which occur when an external object gives rise to a sensation consist of a number of different processes. We need not consider whether there is really such a thing as an external object, but we assume that there is some external cause for the sensation. All our attempts to analyse the processes are again reduced to a series of sensations, and it is on such a basis we build up our ideas of a physical universe.

As the result of such analysis we are lead to the view that all sensations, which are not hallucinations, are related to impulses which travel up sensory nerve fibres. Dr. Adrian's book is concerned with some aspects of the production and conduction of these nerve impulses. Associated with the passage of a nerve impulse is a change of electrical potential on the surface of the nerve. By means of three-electrode thermionic valves it is possible to amplify the electrical changes to such an extent that the impulses from a single nerve fibre can be recorded and analysed.

One outstanding feature of the processes of sensory reception is that although sensation may be continuous the nerve impulses are discontinuous, in other words, the nervous system is bombarded by a series of discrete impulses. This must be so because after one impulse has passed along a nerve, the nerve enters into a refractory phase during which it is impossible, by any experimental means known up to the present time, to cause another impulse to travel along the nerve.

A second peculiarity is that no one has been able to demonstrate any difference in the impulses no matter what nerve is excited to action. For instance, the electrical and other activities of the nerve is the same whether the resultant sensation is one of sight or of taste (Muller's Law). Thus we are led to believe that the quality of a sensation is anatomical depending on the course of the conducting paths to the central nervous system.

If the above conclusions are correct, the only difference between one stimulation and another will be in the number of impulses passing to the nervous system in a given interval of time. The number of impulses is related to the physical intensity of the stimulus, hence the magnitude of the sensation

is related to the number of impulses per second reaching that part of the nervous system which interprets the sensation.

For those who wish to have a simple and readable account of this view of nervous activity Dr. Adrian's book gives a clear statement of the arguments, based mainly on his own researches on the nervous impulses resulting from stimulation of such nerve endings as those in muscles, skin, and eye.

H. E. Roaf.

History and Historical Research. By C. G. Crump. (Routledge. 5*s*.).

Of late years there has been a tendency for the term "research" to fall into disrepute, largely owing to the fact that much of the so-called research work has been done solely for the production of theses for higher university degrees rather than for its own sake. The author of this stimulating book plainly shows that he has little sympathy with the kind of research suggested by the professor to the student at a loss for a subject. If historical or scientific research is to be made a living thing, it is indispensable, as the author points out, that a student must let his subject take possession of him and not remain in leading strings.

After a short discussion on the type of mind required for genuine research, the book deals with the discovery of a subject, the search for materials, the making of notes, and the final presentation of the results. In every chapter there are to be found valuable hints and sound advice given in the form of fitting aphorisms. For instance, referring to the temptation of the student to bow down to the authorities of a great name, the author remarks that "the scholarly author can hide his ignorances from himself and from his reader so cunningly that neither shall ever discover them." In other words, the student should not take anything for granted, but should always verify the statements on which he bases his conclusions.

Everyone interested in the study of history should read this book, for its broad scholarly outlook extends far beyond the limits of practical research work.

C. Ainsworth Mitchell.

The Human Habitat. By Ellsworth Huntingdon. (Chapman & Hall. 15*s*.).

The remark of a foreign visitor to this country, that England had no climate, but had bad weather, seems to be less depressing after a perusal of this book. For in it we are told that the frequent abrupt changes of weather so characteristic of Western Europe are directly responsible for western civilization. This idea is the main theme of the book, and throughout the volume we hear, time after time, that the climate of any portion of the globe is responsible for the degree of civilization found in that area.

The method employed in the development of the theme is direct and characteristic of an American author. We are introduced to the methods of life of the peoples who inhabit "lands that are too cool," lands "too warm and moist" and, in brief, to the peoples of the whole world. Whether climate is indeed as important in the forming of the habits of a people as the author would have us believe, is a point for discussion, but it would certainly be more scientific to refer any influence which climate may have had to the causes of climate rather than to climate itself. Once the habits of a people are established, natural selection, aided by the inheritance of acquired characteristics, solves all problems according to the author. It seems fairly obvious, however, that many other factors come into play in the development of a civilization, else why did our present civlization arise in Western Europe, rather than in the equally favourable New England states? Of course, climate must have played no small part in the earliest civilizations, but many more influences seem to have been at work.

In colonization again climate is not as all-important as the author believes. The idea that the climate of lands which once supported great civilizations has changed since their period of power, seems to be supported by the evidence deduced from the study of the giant sequoias, which, according to recent correlation with Old World records, afford information as to the variations of the climate of the whole globe. Since colonization of unfavourable lands must undoubtedly occur, if the population of the world increases at the present rate, it behoves all civilized nations to support research institutions in these climates, with the idea of discovering remedies or palliatives. Although not mentioned in the book, this conclusion forces itself on the reader. Strange as it may seem, Great Britain is the least well-equipped of all nations in this respect.

J. E. Halliday.

An Investigation of a Rotating Radio Beacon. (H.M. Stationery Office. 2*s*. 3*d*.).

This report describes experiments carried out by the Department of Scientific and Industrial Research on a radio beacon transmitter, the aerial system of which consisted of a rotating loop or frame coil. After an initial calibration of the beacon a series of tests was made in various ships under actual sea-going conditions, in order to establish the reliability of this system of radio direction finding as an aid to marine navigation. The accuracy of the wireless bearings obtained from the beacon was measured at various distances, and the range of the beacon for reliable working ascertained. The night errors encountered at the longer distances were studied in more detail at various fixed positions, chosen to show the effect of transmission over sea and land respectively.

As a result of these experiments it is proved that the rotating loop beacon can give reliable bearings of the same order of accuracy, and at similar ranges as those obtainable with other systems of wireless direction finding, under the most favourable conditions. A great advantage possessed by the rotating beacon system is that it requires only an ordinary wireless receiver and a suitable watch to enable a ship to take bearings and that the method overcomes certain disadvantages met with when using direction finders on board ship, particularly in the case of small ships. It is, therefore, likely that this system will prove of considerable value in the application of wireless to marine navigation.

Chemical Encyclopaedia. By C. T. Kingzett, F.I.C., F.C.S. Fourth Edition, 1928. (Balliere, Tindall & Cox. 35*s*.).

The new edition of this encyclopaedia will be welcomed by all interested in chemical studies, as well as by general readers who require to make references. It has been considerably enlarged, containing some 200 pages more than the previous edition. The information, without extending into long articles, is usually full enough to give a good idea of the subject, and care seems to have been taken to bring it as nearly as possible up to date. As a test, the reviewer has looked up a number of recent trade names, such as "Prodorite," "Monax," etc., and has found every one he could think of included. Mr. Kingzett, who began this important work during the war years, has done a service by which his name will long be remembered.

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Editorial Notes.

A notable event in the study of cancer was recorded last month at the International Conference on Cancer, by Dr. James Murphy of New York and Dr. Archibald Leitch of the London Cancer Hospital. The result of certain experiments on chickens suggests to them the presence in normal tissues of a "growth substance," which acts as an agent in causing tumours when injected into other chickens. Whether such tumours are true cancers was at first doubtful, but their resemblance is now apparently agreed. Dr. Leitch explained the activity of the growth substance as being due to its unlocking from the healthy cells their own natural growth substance, thus transforming them into tumour cells. That is to say, a tumour is formed from normal tissue cells when these are stimulated in a particular way and by a particular chemical substance. The ferment-like nature of the principle, in this new opinion, has been conclusively established. The theory of Gye and Barnard that cancer is due to a virus is held to be discredited by a test experiment, in which the tumour agent was produced from materials which did not contain a virus. Every discovery in regard to cancer, however, confirms its complex nature, and a combination of factors is by no means improbable. But there will be general agreement with Dr. Leitch's conclusion—and general congratulation—that "the 'growth substance' which has been sought so long in malignant growths may now be within the range of experimental investigation."

* * * * *

To readers of *Discovery* the pronouncement that the agent producing cancer is probably of a ferment-like nature has special interest. For more than a year ago Sir Oliver Lodge contributed to our columns the suggestion that the cause of cancer might resemble catalysis, in that possibly the balance in the tissues was upset by such a chemical agent. Sir Oliver cited the abnormal behaviour of a tungsten lamp-filament when the bulb contains even a trace of moisture: the balance of the gases in the bulb is upset by the moisture which "serves as a stimulus, promoting an action that, once started, continues rapidly of itself, but that would not be able to begin without its outside assistance." The moisture tends to remove the tungsten from the hotter part of the filament and pile it up in another, so that by the growth in one place and the wastage in another, the filament in a short time is destroyed. "The suggestion, then," Sir Oliver wrote, "is that this sort of process that goes on in a lamp, *without any vital organisms or microbes but by the purely chemical activity* of a catalytic agent, may conceivably under certain circumstances go on in the human body." The italics in this quotation are ours; for while, of course, Dr. Murphy had long been at work when these words were published, they illustrate how the physicist and biologist may arrive independently at similar reasoning. Sir Oliver Lodge's article in *Discovery* certainly justified its modest conclusion that "sometimes a hint even from a branch of science outside medicine may be of possible use."

* * * * *

More than a month has elapsed since Captain Amundsen flew from Tromsö to join in the search for General Nobile—since happily rescued—and there is now little hope for his safety. In an appreciation from Professor Gregory, which we publish on another page, the suggestion is made that the lost explorer may be stranded in an isolated part of the Spitsbergen coast: his graphic account of earlier expeditions certainly justifies our contributor's conclusion that should some such plight have occurred, Amundsen, if anyone, can be relied on to make his way out again. So much has been written in the newspapers about the *Italia* that we shall not add to the comments on

the circumstances of General Nobile's rescue. Amundsen himself had at one time bitterly quarrelled with the Italian airman, yet had generously put aside all grievance in going to his aid; and certainly Amundsen would resent the international ill-feeling aroused by another epic of sacrifice, the death of Dr. Malmgren, whose bravery has been justly compared with that of Captain Oates during the Scott expedition. In echoing Professor Gregory's hope that Amundsen may still be alive, we may express our tribute no less to Norway than to Sweden and Italy for their noble contributions to polar research.

* * * * *

On the same day that a letter in *The Times* described the recognition of business training at American universities as a new movement, it happened that the *Evening Standard* reprinted from its issue of a hundred years previously, an extract which showed this important question to be an old one. Speaking at a dinner given in his honour in June, 1828, the Duke of Wellington said (amid "loud applause"), that although he was not a university man himself, he recognized that education could not but be of advantage if properly applied to any career. The suggestion advanced in Dr. James Bowie's letter was that a university education is of little use in business unless it has been directed into specific technical channels; and he prescribed as his alternative a "general education to matriculation standard as a minimum, followed by at least two years' instruction in industrial administration, with intervening periods spent in actual business." In order perhaps to forestall the criticism that as Director of Industrial Administration in the Manchester College of Technology he would naturally prefer such a course, Dr. Bowie proceeded to quote in his favour the Balfour committee report, that business training in the universities is now quite certainly the largest tendency in America. Those, however, who are intimate with academic circles there will have observed an equally strong reaction to this movement.

* * * * *

To recognize that the question chiefly turns on what is the true function of a university does not detract from its importance to industry. Indeed, in the interests of industry itself it will surely be a sad day when the traditional function of the English universities is given second place to technical training. Technical ability is always needed, but what appear to be even more wanted to-day are breadth of mind and a sense of proportion. These faculties may often be acquired through other channels, but they can certainly be obtained from the period for disinterested study and reflection which the years at our older universities afford. A knowledge of routine may usually be acquired afterwards, provided a methodical approach to studies has been learned in even small measure at the university, yet if the business sense is altogether lacking, no amount of special training will inculcate it. It is obviously true, as Dr. Bowie says, that goodwill must depend on efficient management. But if efficiency alone rather than judgment and ability to deal with men is to be the future criterion of our business life, we shall fast lose those traditions which have hitherto distinguished it from the more mechanical and less personal atmosphere of American industry.

* * * * *

This month we publish some notes and articles of travel interest, as many readers will be on holiday by the time this number is available. Our next number will, as usual, be devoted to the British Association, to coincide with the meeting in Glasgow at the beginning of September. As in previous years, some account will be given of the Association programme and several articles on current problems are due for inclusion. Arrangements have been made whereby members attending the meeting may obtain copies, and we confidently ask the fullest support from our readers in making this annual "special number" as widely known as possible. A specimen copy of *Discovery* will always be gladly sent on request.

* * * * *

A satisfactory outcome has followed the complaint voiced by *Nature* in regard to films brought into this country for scientific purposes. Disappointment was caused at a meeting of the British Association by the exclusion of a film of Chilian and Peruvian birds with which Mr. R. C. Murphy, of the American Museum of Natural History, had intended to illustrate a lecture. This year two similar incidents again occurred. Mr. Beebe, the eminent naturalist, was obliged to pay full duty and Mr. Wright, the distinguished American astronomer who wished to use a film to illustrate a lecture before the Royal Astronomical Society, not only had to pay duty on his film, but was also put to a good deal of trouble by the Customs authorities. Accordingly, the Association of Scientific Workers drew attention to the matter in Government quarters, and a decision has just been reached to allow the exemption of scientific films from duty. The question of their preparation also deserves special attention. We know of one leading British photographer who formerly developed the films of an American museum working in Egypt, but owing to the duties British industry has lost a large revenue from this source.

Wireless in Mineral Prospecting

By F. J. North, D.Sc., F.G.S.

Department of Geology, National Museum of Wales.

Considerable success is now being obtained with the use of wireless for detecting minerals, mainly as the result of research in the United States. Many details have still to be worked out before this new process can be generally employed by surveyors. Special study of geophysical methods will be undertaken in Australia.

SINCE the days when mining for metals first commenced, there has always been an incentive to the discovery of methods for detecting ore-bodies that give no surface indication of their existence. Some have professed to do this by means of the divining-rod, but even as far back as 1556 George Agricola, whose books were, for more than two centuries, the world's standard works upon mining and metallurgy, dismissed the divining-rod as being useless and unnecessary. After a careful examination of the claims made for it, he came to the conclusion that no ore had ever been found by its means that the miner would not have discovered on account of " the natural indications of the veins which he can see for himself without the help of twigs."

Later on, when other methods based upon the physical properties of matter were introduced—geophysical methods as they are called—they, too, were at first regarded with suspicion as being of the same order as the discredited hazel twig. This, however, is by no means the case, because they are based upon natural laws relating to properties such as the gravity or density of bodies, or to their reaction to magnetism and electricity. Before proceeding to discuss wireless methods of surveying it may be well to outline briefly the principles underlying the application of geophysical methods in general.

Research in Australia.

Attention has recently been directed to such methods of surveying by an arrangement between the Australian Government and the Empire Marketing Board, whereby a special study of the subject will be undertaken in Australia. The nature and arrangement of the rocks of the earth's crust can be ascertained by these methods without first obtaining direct access to them by excavations and borings [3]*.

Metallic ores sometimes occur in veins or lodes that penetrate the rocks of the earth's crust as relatively thin wall-like masses (Fig. 1A), or the occurrences may be irregular in shape and sporadic in distribution (Fig. 1B). The formation of veins and lodes is subsequent to that of the rocks in which they occur; they do not of necessity bear any definite relation to the original structural features of those rocks (for example, in the case of rocks that accumulated as sediments, the layers in which they were deposited), but they often occupy fissures, such as joints or faults that have been widened because the material on either side of the fissures has been dissolved away, or because of movements in the earth's crust.

* Numbers in brackets relate to list of references on page 243.

Geological Factors.

The prevailing directions of the joints and faults in any region are usually related to the disturbances to which its rocks have been subjected. Owing to the removal by atmospheric weathering (denudation) of the material that may once have covered them, the edges of veins and lodes usually appear at the surface, and the discovery of their position and of their relation to the enclosing rocks therefore depends to a large extent upon a proper appreciation of the geological structure of the area in which they occur.

The location of irregular ore bodies is more difficult. They may bear a definite relation to the arrangement of the rocks among which they occur, but they may swell out or die away according to no apparent system. Further, while there are often signs that would indicate to an experienced miner, who had come to the end of an ore-body, in which way he should go to reach the next, there is usually nothing to show whether another mass does actually exist, and if it does, how far away it is, or what will be its size. It may also happen that owing to the stage reached by denudation in the district concerned, there may be no surface indication whatever of the existence of an ore-body, and nothing to indicate its size and position, even if the nature and arrangement of the rocks are such that one may be expected to occur. This also applies to lodes when, as is sometimes the case, the surface of the rocks in which they occur is covered by a considerable thickness of superficial deposits, like those present in regions that were covered by ice during the last great Ice Age (Fig. 1C).

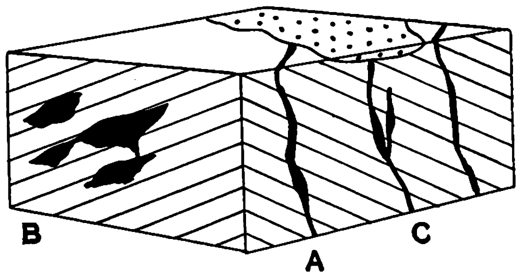

FIG. 1.
HOW ORE BODIES OCCUR.
(A) A vein or lode which reaches the surface; (C) A lode, not exposed at the surface on account of a covering of "drift" deposits; (B) Irregular ore masses, of which there are no surface indications.

In the methods employed to determine the position and extent of hidden ore-bodies (or the juxtaposition of different kinds of rock beneath the surface, for the principles involved are the same), advantage is taken of several properties that can be detected at a distance. Some methods relate to the attractive force of gravity, others to the magnetic or electric properties of bodies by reason of which they may generate or transmit magnetic force or electric currents.

The gravity methods depend upon the fact that the attractive force of a body is related to its density—they employ the principles upon which Nevil Maskelyne conducted his pendulum experiments at Schiehallion in Perthshire (1775), and determined the weight of the earth, and upon which Henry Cavendish (in 1798) based his determination of its weight by measuring the twisting or torsion, due to gravity attraction, of a wire from which weights were suspended. One of the most successful modern appliances for geophysical surveying—the Eötvös torsion balance*—employs the principle of the Cavendish torsion experiment.

The magnetic methods depend for their operation upon the fact that the earth acts as a large magnet; a magnetized needle, suspended in a horizontal position (Fig. 2A) normally points to the magnetic north, while a similar needle suspended so as to swing in a vertical plane, points or "dips" towards the ground (Fig. 2B). The angle by which the horizontal needle deviates from the direction of the true north, and the angle of dip of the vertical needle, are known for many parts of the earth, and in the neighbourhood of an ore-body consisting of material with magnetic properties,both needles will deviate from the direction they would normally assume at the place in question. In this way, the site and approximate boundaries of such a mass can be determined, because by joining up on a map all places where the deviation of the compass needle is the same (giving isogonic lines†), the presence and shape of a buried mass will be indicated by the deflection of the lines from the normal for the district. By connecting points of equal dip of the vertical needle (giving isoclinic lines, or lines of equal inclination) the relative intensity of the magnetic attraction exerted by the concealed body can also be gauged, and this information throws light upon its nature and its depth beneath the surface.

Several methods of prospecting take advantage of differences in the electrical conductivity of rocks; for example, electricity from a portable generator is allowed to pass between two electrodes, usually in the form of rods stuck into the ground, and the currents passing through the rocks are detected by means of

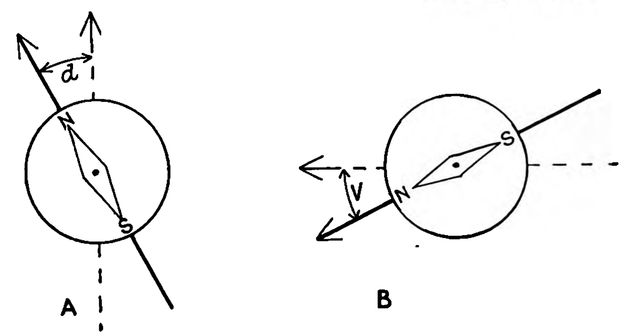

FIG. 2.
INFLUENCES OF ORES ON A COMPASS.
The compass needle (A) deviates from the true north by an angle (d), and a magnetic needle swinging in a vertical plane, (B) Points downward or "dips" at an angle (v). The angles d and v vary from place to place, and are affected by the presence of a magnetic body.

two other rods connected to a sensitive galvanometer. The object is to trace all the spots of equal electric pressure or "potential," and by connecting them, to indicate upon a map, lines of equal potential—"equipotential" lines—corresponding to the isogonal lines and the isoclinal lines of the magnetic methods.

If the material in which the electric field has been produced is of equal conductivity throughout, the flow of the current will be regular, and so will the equipotential lines, which, connecting points of equal electrical pressure, will be at right angles to those representing the direction of current flow (Fig. 3A). Where, however, bodies of different conductivities meet, the equipotential lines will be bent, coming together above bad conductors (Fig. 3C), and spreading out above good ones (Fig. 3B). In this way, the manner in which the equipotential lines deviate from what would be expected if no differently conducting material were present, indicates, when properly

* See *Discovery*, Vol. VI, p. 141.

† Isogonic lines, or lines of equal angles, correspond to the contour lines on a map, which are lines of equal elevation, and to isobars on weather charts, which are lines of equal barometric pressure.

interpreted, the existence and position of an ore-body.

Magnetic and electrical methods of prospecting were greatly advanced as a result of the research carried out during the War on the detection of submarines. A submarine in motion could be detected because of its effect upon the water or by the noise of its propellers, but a submerged submarine at rest may also be found, as it is similar in some of its properties to a buried ore-body. Being largely of steel, it affects the magnetic needle; consisting of more than one kind of metal immersed in sea-water, it acts like an electric battery and generates electricity; and being a conductor of electricity, currents could be "induced" in it. By taking advantage of these properties the detection of stationary submarines was developed into a fine art, and since the principles involved are similar, magnetic and electrical methods of prospecting have made great progress in the last few years, especially in Sweden [1].

It is only natural that as wireless electrical communication passed from the experimental to the practical stage, attempts should be made to apply "wireless" to geophysical surveying, and most of the work in this connexion seems to have been done in North America. The reason for this is that, like all other geophysical methods, it supplements, but cannot entirely replace, exploration based on geological principles. In this country the metalliferous areas have been so long worked and the distribution of the ore is well known, that there has not been the same inducement to introduce fresh methods of prospecting as is the case in North America, where there are vast areas in which metalliferous deposits may be expected to occur, and of which the geological structure is practically unknown. The United States Department of Commerce has recently published a pamphlet by Drs. Eve and Keys, in which all the methods of geophysical surveying are reviewed, and the principles of the wireless methods discussed [2]. The following notes are, to some extent, based upon that pamphlet.

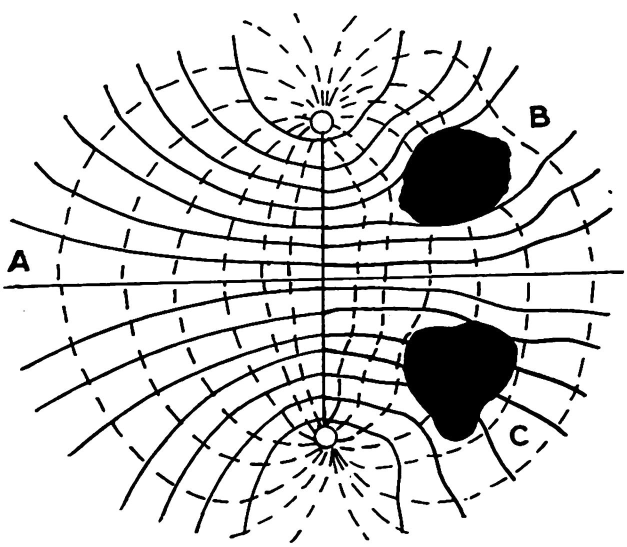

FIG. 3.
THE PATHS OF AN EARTHED CURRENT.
Diagrammatic representation of the flow of current (broken lines) through the ground between two earthed electrodes, and the lines of equal electrical pressure or equipotential lines (continuous lines). Details are given in the text.

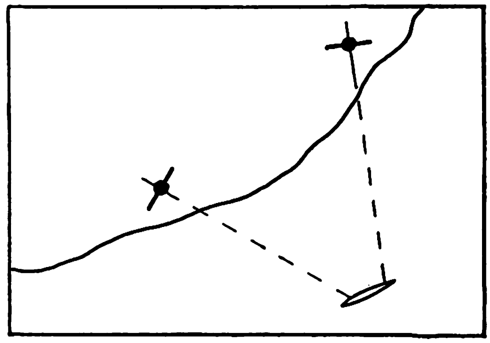
FIG. 4.
WIRELESS LOCATION OF SHIPS.
Analagous principle of the location of ships sending out wireless signals.

Wireless methods of prospecting are somewhat akin to those used in the location of ships at sea; a coil at a coast station receives signals of maximum strength when its plane points towards a ship sending out signals, and receives signals of minimum strength when its plane is at right angles to their source (Fig. 4).

In the case of an ore body, which cannot transmit signals, the first step, as is the case in the electromagnetic methods, is to excite it by transmission from a suitable aerial; in one of the methods that are being tried, a loop aerial is used. The waves from a vertical loop (Fig. 5A) will penetrate to an ore-body, not too deeply buried, and being re-radiated can be detected by a suitable receiving set (Fig. 5B). The latter will also receive waves passing directly through the air from the transmitting loop, and these will not only be much more powerful, but will almost certainly not be in "step" or in "phase" with those received from the ore-body. This difficulty can, however, be overcome by altering the frequency in the transmitting loop, and tuning the receiving coil until the signals received from the aerial and the ore-body are in phase.

Having made these adjustments, the signals will vary in strength according to the relation between the position of the direction-finding coil and the position of the buried body from which they have been re-radiated. They will be at a minimum when the plane of the coil points in a direction that is a resultant of two vectors (as a quantity involving both direction and magnitude is called), the one relating

to the ore and the other to the transmitting loop. In Fig. 6, each vector is represented by a straight line, the length of which indicates the relative intensity of the signals, and which points in the direction whence the signals were received. The vertical line (A) is the vector relating to the principal waves received directly from the transmitting loop, and the inclined line (B), the vector relating to the ore ; the resultant direction is obtained by completing the parallelogram, and continuing the diagonal (D).

It is found that the direction-finding coil receives currents of minimum strength when its plane points in the direction of the ore-body, but below it, and if observations are taken at a number of places, the position of the ore-body is indicated. In successful experiments that have been conducted, the frequency in the transmitter varies from 19,000 to 150,000 cycles per second, and the wave-length from 2,000 to 16,000 metres.

At present there is a dearth of reliable information concerning the extent to which wireless waves can penetrate into the earth, or are affected by the nature of the rocks and by their relative wetness and dryness. A moment's reflection will enable one to realize that in railway tunnels the waves might pass along the airway or be carried by the rails. Even in deep mines, where the air passage from the shaft mouth to a chosen spot underground may be so tortuous as to preclude any possibility of the waves reaching the receiver by open channels, various conducting bodies—such as electric cables, pipes conveying air or water, and tram rails—penetrate into practically every part in which experiments could be conducted with safety.

Interesting experiments in this connexion have been conducted by Dr. A. S. Eve of the McGill University, Montreal, in collaboration with the United States

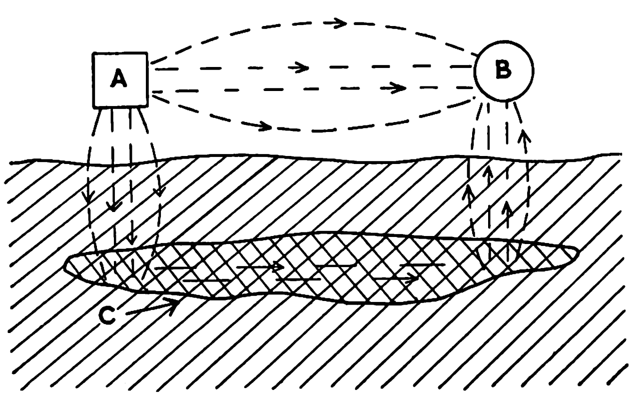

Fig. 5.
PRINCIPLE OF WIRELESS PROSPECTING.
Signals sent from a station A are received at B, in part directly through the air, and in part by way of a concealed ore-body (C), the electrical conductivity of which differs from that of the surrounding rocks. (*After Eve and Keys.*)

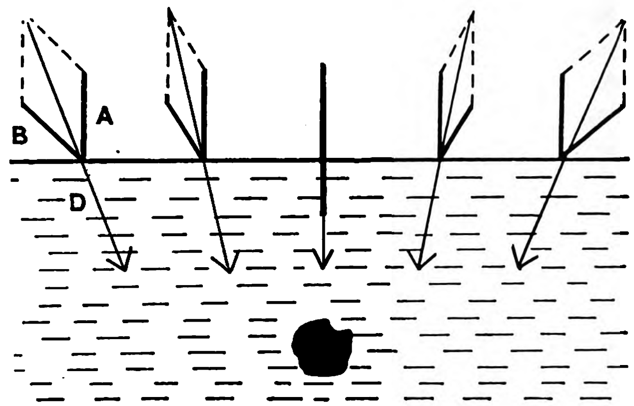

Fig. 6.
A PRACTICAL EXAMPLE.
Diagram illustrating the location of an ore-body by means of a number of observations on the direction and intensity of wireless signals, sent and received by the method indicated in Fig. 5. (A) The vector relating to signals received directly by wireless through the air; and (B) the vector relating to signals received partly by way of the conducting ore-body. (*After Eve and Keys.*)

Bureau of Mines. Dr. Eve, working in a long railway tunnel at Montreal, found that wireless signals of short wave-length (40 metres) could not be detected at a comparatively short distance within the tunnel, although broadcast waves (400 metres) were detected in the middle of the tunnel beneath a cover of 700 feet of rock, and waves of 10,000 metres length were detected much more readily. In such experiments the possibility that the transmission was assisted by the electric wires and rails in the tunnel has to be considered, but in any case the short waves penetrated for a short distance only.

The effect of moisture in the rocks has also to be taken into account, because experiments with submarines have shown that wireless waves do not penetrate very far into sea water.

A few months later Dr. Eve and others conducted further tests in the famous Caribou Mine, Colorado, using a nine-valve wireless set. At a depth of 220 feet, in a tunnel free from wire, rails, and pipes, a concert broadcast from Denver, more than fifty miles away, was clearly received. At a depth of 550 feet poor reception was recorded on an occasion when equally poor reception was experienced at the surface ; but a concert was clearly received at that depth, at the end of a passage 80 feet from any metalliferous conductor, when the reception was good above ground. Here, again, the possibility of the wireless waves having come by way of air channels and having been influenced by metallic conductors has to be considered, but the path to the spot where the experiments were made was very tortuous and the signals were received at maximum strength when the loop faced, not along tunnels or towards near-by conductors in the mine, but in the direction of Denver.

The experiments seem to indicate that wireless waves which will penetrate 50 or 60 feet in a good conductor like sea water will penetrate much further —at least up to 500 or 600 feet—in poor conductors, such as the average rocks of the earth's crust when they are relatively dry.

Another matter about which, at present, doubt exists, is the extent to which the phenomenon is one of real re-radiation of wireless rays, or one of induction —that is to say, the production of an electro-motive force in one electric circuit through the agency of another, without any direct electrical connexion between the two, which is the working principle of many important appliances such as the transformer. This possibility is rendered more likely by the fact that in any places where tests can be undertaken, or in any ore-bodies that miners can hope to reach, the distance beneath the surface is comparatively small compared with the wave-lengths involved.

In the foregoing pages sufficient has been written to indicate the general principles upon which some of of the geophysical methods of surveying are based, and to show that although their object is to detect materials without actually coming into contact with them, they rest upon a sound scientific basis. Each of the methods has its own sphere of usefulness and its own limitations; for example, the magnetic and electrical methods appear to be most successful when dealing with the metallic ore-bodies, and the gravity methods in the case of non-metallic materials such as oil, salt, and coal. But in conjunction with geological knowledge there can be no doubt that geophysical methods can be used successfully in the exploration of the earth's crust, and will prove of the utmost value to not only the prospector but also to the physicist and the geologist.

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Raold Amundsen: An Appreciation.

By J. W. Gregory, D.Sc., F.R.S.

Professor of Geology in the University of Glasgow.

Without detracting from the hope that Amundsen may yet be found alive—as we go to press there is still no news—we feel the moment appropriate to review the career of this great Norwegian. Our contributor, Professor Gregory, has himself explored in the polar regions; he does not shirk to deal frankly with the famous Curzon controversy, and he concludes with an interesting suggestion as to Amundsen's present plight.

Raold Amundsen will doubtless live in the annals of polar exploration as one of the outstanding figures, owing to the genius and insight which enabled him to carry through successfully a unique series of Arctic and Antarctic adventures. He was born on 16th July, 1872, the son of a Norwegian shipowner. He began the study of medicine at Oslo University, but he early felt the call of the sea and of the Arctic, and went to sea in 1894. He was one of those young Norwegians whom the national sentiment, as Eva Nansen's song has it,

Gave them the wish to wander;
  To leave our shores and turn their prow
Towards night and perils yonder.
  Thou pointed'st to the open sea,
The long cape was thy finger;
  The white sail wings they got from thee,
Thou cans't not bid them linger!

In obedience to that impulse Amundsen devoted his life to polar research, and spent it in a series of circum-polar journeys which are unrivalled for their extent and uniform success.

Amundsen's first share in polar exploration was as lieutenant in the Belgian Antarctic Expedition under de Gerlache, which in 1897-9 made important additions to knowledge of the archipelagoes south of the South Atlantic. In 1903 he started on his first independent expedition, in the *Gjöa*, a sloop of 47 tons with an auxiliary motor engine of 39 horse-power. He had six companions. They crossed to Greenland, entered Lancaster Sound, and were frozen in for two years in Gjöa Harbour in King William's Land; there they made many useful meteorological and magnetic observations, charted some of the coasts, and redetermined the position of the North Magnetic Pole. In August, 1905, the *Gjöa* was set free but was frozen in again off King Point, and after a third winter in the ice was released again on 11th July, 1906, and next

month entered the Pacific. The *Gjöa* is the only vessel that has achieved the North-West Passage.

In 1910 Amundsen started on his most famous journey. He sailed from Norway in Nansen's vessel, the *Fram*, ostensibly to take her *via* the Atlantic and Pacific to Behring Strait, and thence drift across the North Pole. He had not, however, an adequate equipment for that project, and to secure the necessary funds for it he halted on the way in the Ross Sea, wintered on the edge of Ross' Great Ice Barrier, and after a swift inadventurous sledge journey reached the South Pole on 16th December, 1911, before the British Expedition under Scott. Amundsen with his usual thoroughness made a series of traverses and set up signals around the Pole, so as to avoid any chance of question as to his having attained the Pole. The remarkable feature in this journey was the ease with which it was made, in contrast to the strenuous efforts by which Scott and his party reached the South Pole and to the tragedy of the return. The feeling that Scott's intense disappointment at having been forestalled contributed to the disaster, led to some expressions of resentment at Amundsen's having gained the South Pole as a side-trip in his proposed trans-Arctic drift; but the general feeling in this country was of genuine admiration for one of the masterpieces of polar travel.

First Air Experiments.

Amundsen's expedition to the South Pole secured him the funds for further enterprise. In 1918, in a new vessel, the *Maud*, he sailed *via* the Pacific for Behring Strait, intending to drift across the Arctic Ocean. He hoped, by entering the pack further east than the *Fram*, to be carried nearer the Pole than the route of Nansen and Sverdrup. But the drift of the ice was too irregular and the voyage failed in its main purpose.

While at Seattle on the voyage north with the *Maud* Amundsen heard of the success of an all-aluminium aeroplane; and with characteristic insight, he realized that this machine could withstand any degree of cold and should render possible in circum-polar work what was still impossible. Amundsen at once began experiments with aeroplanes, but they were costly failures.

He took two aeroplanes on the *Maud*, but they both crashed. Amundsen, however, learnt much from them; he persisted in his efforts and became the pioneer in polar aerial exploration. A donation of 85,000 dollars from J. W. Ellsworth provided Amundsen with two hydroplanes, and in 1925 he tried to fly from Spitsbergen to the North Pole. About 100 miles from it he had to descend in fog; the machines sank into the slush on the floes, and only after a month's strenuous labour—in the intervals of which he sounded the sea beneath and by finding a depth of over 11,000 feet showed that there was probably no land at the Pole—during a day of severe frost one of the two machines was freed, and by abandoning all their stores they made the flight of 550 miles back to Spitsbergen. The party had been abandoned as lost, but they met a sloop which towed the hydroplane back to safety.

With characteristic tenacity Amundsen next year tried again, in an Italian built airship, the *Norge*. By a triumphant voyage of 2,700 miles in 71 hours he twice circumnavigated the Pole, crossed the Arctic Ocean to Point Barrow in Alaska, and landed at Teller in the Behring Sea.

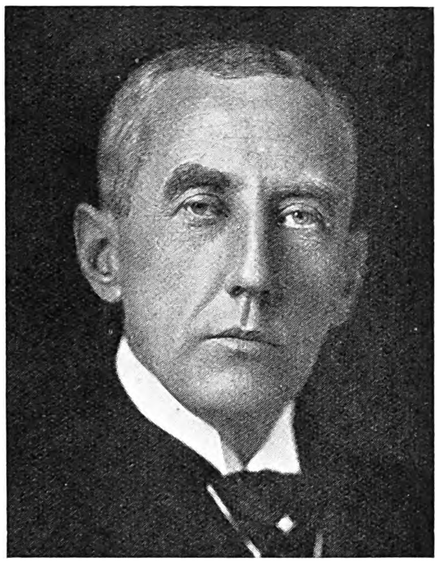
Amundsen is no doubt inferior to his compatriot Nansen as a scientific geographer, and though he has contributed largely to knowledge of the Arctic regions, his work was inspired by his passion for Arctic travel and his success was due to the insight and imagination which enabled him to select appropriate methods and conquer the special difficulties.

Amundsen's greatest gift was his mastery of the technique of circum-polar travel. He chose methods which enabled him to carry through with ease journeys which otherwise required exhausting efforts or proved impossible. Though he narrowly escaped in 1925, he got all his men back safely, and showed that the hydroplane cannot be trusted on a frozen sea. He showed great originality in designing equipment, as in his solar-compass, which, as made by Goerz, enables an aeroplane to be steered where the magnetic compass is useless owing to proximity to the magnetic pole. Amundsen's prevision in preparation and skill in the selection of methods amounted to genius; and that capacity, combined with his powers as a leader and in securing the confidence of his companions, gained him his unfailing success.

Amundsen, in fact, suffered in popular reputation by the skill with which he performed with apparent ease feats which others achieved at the cost of heroic endurance and disaster. Franklin gained immortality by the cannibalism of his starving men on the Mackenzie River and the loss of the whole of his last expedition. How many people remember the names of Dease and Simpson, the two agents of the Hudson Bay Company who quietly did what Franklin had failed to do, or of John Rae, the young doctor who by first wintering in the Arctic with only a summer marching equipment, found the first evidence of Franklin's fate?

By the intuitions which enabled Amundsen to discover how dangers could be avoided and the way made practicable he, in the sphere of current polar work, may be compared to Captain Cook who rendered possible long voyages in the equatorial and southern seas. As a man and a leader of men, he has most resemblance, amongst contemporary explorers, to Shackleton.

Amundsen's last connexion with British geography was deeply regrettable. He was in many ways like an Elizabethan navigator, and was likely to treat what he regarded as sarcastic disparagement in the spirit of Drake and Frobisher's quarrel, after the Armada was over, about Don Pedro de Valdes' galleon. In an autobiographical chapter he revealed his profound resentment at remarks made by Lord Curzon, who as President of the Royal Geographical Society was chairman at his lecture in the Albert Hall on his South Pole expedition. As Lord Curzon was dead, the Council of the Society felt bound to repudiate the charge of rudeness to their distinguished guest. Amundsen's memory of the facts was defective and his complaint was blunt, and as the impression on him was ineradicable his name was removed from the list of Honorary Fellows of the Society.



Swaine

RAOLD AMUNDSEN.

When judging of the incident I cannot but remember how Lord Curzon, after his election as Lord Rector of Glasgow University, infuriated his admiring and enthusiastic constituents and how, in one of the select gatherings to welcome him, he mortified a group of bystanders by a tactless remark to an acquaintance made in simple absent-minded oblivion that it would be heard by all those around him. In my own limited relations and correspondence with Lord Curzon I always found him charmingly courteous and singularly modest in his judgment; but such was not his reputation. He was popularly credited with unique powers of exasperation, due to his occasional awkwardness of manner and his unlucky habit of thinking aloud. Some of his critics in India declared that he was only more riling when speaking in friendly patronage when he was trying to be playfully facetious. Chaffing a man in a foreign language is notoriously liable to misunderstanding; and Amundsen's deep-rooted annoyance was probably due to his confused recollection of jocular remarks made in conversation as well as with the speech as chairman. But as Amundsen made no protest shortly afterwards, it was no use expressing his resentment when twenty-five years brooding had exaggerated the fancied insult and death had prevented the simple solution of an assurance from Lord Curzon that his remarks had been utterly misunderstood. Is there any doubt that Lord Curzon would have been Premier, and probably the greatest Premier of his time, if his trail had not been littered with men like Amundsen suffering acutely from his powers of unwitting exasperation?

Amundsen's own interest in polar exploring was more in the excitement of the work than in the results. He felt that "Things won are done; joy's soul lies in the doing." He has not the abiding interest in geographical problems of Nansen, but loves Arctic travel for its own sake. Hence it was in accordance with his natural instincts to join in the rescue of the crew of the *Italia*. He doubtless volunteered the more readily owing to his quarrel with General Nobile during the former flight, and he chivalrously, in spite of his fifty-six years of age, joined in the quest in the first machine available. He left Tromsoe on 18th June in a French hydroplane, and has not been heard of since. Repeated disasters have happened in the efforts at aerial navigation in the Arctic, beginning with the disappearance of Andrée in 1897, owing to the failure of devices designed in temperate climates to stand prolonged reliability trials under Arctic conditions. The French hydroplane has apparently failed like Amundsen's two machines in 1925. But it must have had adequate fuel to carry it to any part of Spitsbergen, and it may have landed, crippled, in one of the many bays on the eastern coasts.

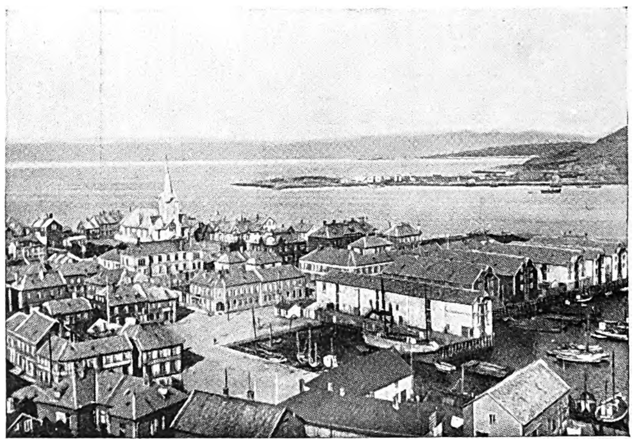
Hence there is still good hopes for his safety. He was more than a month overdue in 1925; and full confidence may be felt in his power, if he has landed in some remote part of Spitsbergen, to turn to account the resources of the country, and make his way in the autumn to the settlements on the western coast. But if fate has been cruel and Amundsen has perished in his gallant effort to rescue the survivors of the *Italia*, his sacrifice will be a noble ending to a great career.

The Most Northerly Town in the World.

By John Andrews.

The writer has just returned from a four thousand miles cruise to Hammerfest, near the North Cape, which afforded new and varied interests. On this route may be seen the summer quarters of the Lapps, one of the few peoples who still retain their primitive dress and customs.

NORWAY to-day is making every effort to attract her share of the British tourists who since the war have flocked in increasing numbers to the continent. Fortunately for those who avoid the beaten track the country is still unaffected by the standardization which elsewhere has followed this traffic, but as the Norwegians are closely akin to the British, the novel conditions can be enjoyed without the discomforts of other lesser known countries in the south. Next month will see the close of the National Exhibition, held during the summer in Bergen for the joint purpose of promoting trade and of advertising the hotel and travel services which Norway has to offer.



VIEW OF THE TOWN AND HARBOUR.
Almost every house in Hammerfest is built of wood. Across the harbour is seen a tongue of land, the Fuglenes, which marks the north end of the meridian 25° 21'.

Just as the North Cape was "unknown" to Longfellow—

> And then uprose before me,
> Upon the water's edge,
> The huge and haggard shape
> Of that unknown North Cape,
> Whose form is like a wedge.

—it is still not often visited, although in 1802 it had formed the subject of a travel book published in London. The steamer* from Bergen steers its northward course as much as possible behind the coastal islands, and in reaching the final port of call, Kirkenes, it travels round Magerö, where the North Cape is situated. Fifty miles below the Cape, itself the peak of Europe, is Hammerfest—the most northerly town in the world.

As the steamer nears the quay there may be seen near-by two groups of fenced-in trees, which the Norwegians proudly term the world's most northern "park." The trees in no case are more than ten feet high and show signs of frequent renewal, some of their number being replaced every spring despite the screens which in winter are erected to protect them. On the other side of the Sadlen—a hill of saddle shape ascending steeply behind the town—a small copse of birch trees rivals the park, and a new private residence now boasts a few shrubs in its carefully tended garden.

Across the harbour is the Fuglenes, the cape where in 1823 Sir Edward Sabine made his historic experiments with the pendulum. A granite column mounted with a globe marks at this spot the north end of the meridian 25° 21' long., which was traced from the Arctic Ocean to Ismail on the Danube, by way of Norway, Sweden, and Russia. This tremendous labour was carried out by Royal command in the three countries during the period 1816-1852.

From 14th May to 29th July the sun never sets at Hammerfest, and likewise it is not visible at all from 21st November to 23rd January. It is therefore not surprising that tuberculosis is prevalent among the fishermen inhabitants—their wooden houses, in many cases scarcely more than huts, have closed windows for the greater part of the year, and the sanitary conditions also are primitive. A fine new hospital—not yet opened—overlooks the harbour, and is a reminder that to the early nursing efforts of some visiting Sisters who founded a Catholic community, Hammerfest owes the distinction of having a Roman Catholic church, although its population is but three thousand—Norway is overwhelmingly Protestant.

The northern outlook from the Fuglenes is uninterrupted by islands and affords an excellent view of the Midnight Sun, as it hovers as a stationary ball above the horizon, at its lowest angle, before

* The voyage here described was made in the *Kong Harald* and the *Haakon VII*, both vessels in the service of the B. & N. Norwegian Royal Mail Line.

again mounting in the sky. The North Cape itself is perhaps the most renowned point for observation, but the sun may be seen on many nights while the steamer is travelling within the Arctic Circle. Frequently the sun itself is obscured by coastal mountains or clouds, yet in such cases most wonderful colourings are effected in the sky. The view which the writer enjoyed best was at Tromsö, on the southward journey; after an unsettled day that had opened with rain and mist, the sun at midnight blazed forth from behind some deep mauve clouds and enveloped the white wooden buildings of the town in a rich orange glow.

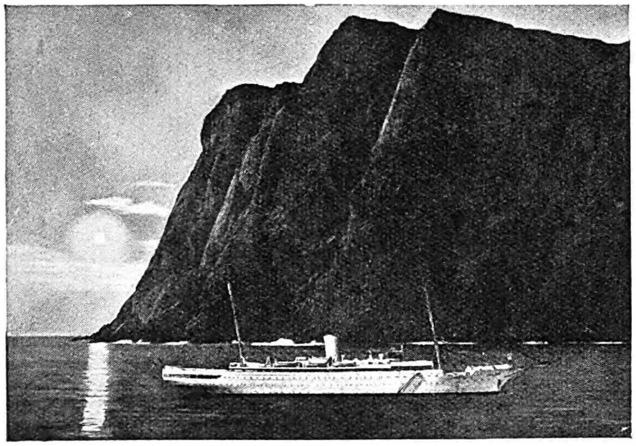
Tromsö was at this time the headquarters of the Italian airmen who were among those searching the southern Arctic for Amundsen. As it rested on the harbour waters, their seaplane was in quaint contrast to the fishing boats, and it emphasized the keen anxiety felt in the fate of the great explorer, of whom all Norwegians are justly proud. Tromsö has been the base of many polar expeditions, as well as of Arctic hunters of seal, walrus and whale, and in the interesting local museum a section is also devoted to Lapp exhibits. Off the Norwegian coast itself, whaling is legally forbidden, as the whales are helpful to the fishermen in driving shoals of fish into the shore waters.

THE "PARK" AT HAMMERFEST.
The trees in the fenced enclosure (on the left) are tended with great care, as they are the most northerly grown in the world. Frequent replanting is necessary

In sharp contrast with the bleak character of Hammerfest and other Arctic ports of call is Molde, the "City of the Roses." With honeysuckle and other flowers the roses flourish here, and across the fjord a panorama of forty-six mountain peaks presents one of the grandest views in Norway. But perhaps the most unusual of the islands passed on the cruise is Torghatten, where a natural tunnel leads through the rock. Some of the larger steamers stop at this point to allow passengers to climb the mountain. The tunnel is over two hundred feet high and as wide as the nave of a cathedral, yet from the sea it appears no larger than a keyhole. Another natural feature that has an air of weirdness is afforded by the Trold (or "witch") Fjord, where the steamer heads for an apparently solid wall of rock; but soon a narrow channel is revealed, leading into a deep pool that forms a pocket in the mountain side. Here the cliffs give back an echo, when the ship's whistle is sounded, as if the *trolds* were mocking—from this the fjord takes its name. The peaks of the Lofoten mountains are seen towering above, as the steamer emerges again into the wider waters of the Raftsund.

The only industry at Hammerfest is fishing, and the harbour is the second centre for the fleets which set out each year for the Polar Seas—the most important is Tromsö, where a big trade in furs is also carried on. The unequalled scope for fishing which the sheltered coast provides has made the Norse a race of sailors, and it is estimated that nearly half of the four millions which make up their number have become scattered over the globe. Emigration to the United States accounts for a considerable proportion—Chicago is jocularly termed the "second largest town in Norway"—but there are colonies in many ports, especially in Canada, South Africa and Australia. During the war the Norwegian fishing trade experienced enormous prosperity owing to the rival demands for this neutral supply of foodstuffs; a year after the Armistice, at Haugesund, for example, there were still to be seen thousands of barrels of putrified herrings, which had first been ordered by Germany but afterwards bought for a higher price by England, although transportation from Norway was never undertaken.

Fishing is accomplished during the winter months, and at this time of year—the voyage here described was made in July—the traveller will see the drying and packing processes in operation at every village. In the more southern ports vast quantities of haddock are undergoing treatment: after gutting and cleaning, the fish are stacked in octagonal piles and covered with wooden lids. In the storing yards the piles are closely placed, but along the shore they are to be seen arranged at intervals, for better exposure to the sun, and resembling groups of beehives or haystacks. If space allows the fish are sometimes spread out singly on the ground during the day, to be piled and covered again at night. For smaller fish other methods are employed, and in the northern villages the cod, for example, are tied in pairs and hung over poles supported on trestles. Many rows are staked out.



THE MIDNIGHT SUN BEYOND THE NORTH CAPE.
On clear evenings an uninterrupted view is obtained from "the huge and haggard shape" which rises vertically out of the sea. The motor yacht *Stellar Polaris* seen in the foreground clearly indicates the proportions of the Cape.

on the beach and some of the drying areas cover hundreds of square yards. The wind no less than the sun is effective in drying, and afterwards the fish are packed in wooden cases for export, a large trade being done with the Mediterranean and other Catholic countries. The waste bones and fish heads are turned into guano, and in the absence of a breeze—or if the wind blows towards the shore—the noxious smell of this manufacture is overwhelming. The natives, however, are said not to notice it, so accustomed do they become to what is after all one of their staple industries.

During the long cruise up the Norwegian coast, the steamer calls in twice a day—sometimes the port has twenty thousand inhabitants, at others a rowing boat comes out to take off a single passenger. There are no coastal railways and everywhere the steamer is the only link with the outer world. As the traveller cruises along—a part of that world, yet removed ever farther from it—there are two observations at least which cannot escape him.

Whatever turmoil, he reflects, may disturb the main continental countries, here in such sheltered places life goes on unchanged, in essentials just as it has done for hundreds of years. Against the rugged background its permanence is clearly defined—this universal message of Nature in less isolated places is contaminated by the disturbances nearer at hand.

Yet these fishing people in Norway, paradoxically, are so completely "westernized" that as they gather on every quayside to welcome the steamer—the girls in their silk stockings and high-heeled shoes, the men with bowlers and (in one case) in spats—they might equally be waiting for a 'bus in a London thoroughfare! This reflection is a humorous one, but however disillusioning to the artist, it does not necessarily discredit civilization. Rather, the preference for modern modes and fashions appears to reflect in their favour, though precisely why they appeal remains a mystery. Modern commerce, of course, is spreading its products to every corner of the world, and people whose lives are sheltered may find exhilaration in being "up to date." The obvious fact that bowlers are not the most harmonious hats for fishermen, perhaps strikes only the sophisticated traveller, who is all the time compensating for his greater separation from the hand-to-mouth existence. And the same ship which brings the hats to Hammerfest is also carrying a cargo of medicine, linen, and soap.

If the fishing villages are losing their native character—and the telephone and electric light, everywhere used in Norway, are contributing factors to this change—there is ample compensation in the primitive condition of the Lapps. Except perhaps for a growing trade in reindeer knives and other "souvenirs," these people remain untouched by modern influences and tend their herds in just the same way as their earliest ancestors.

In the spring there is a westerly movement to the coast, when families of Lapps bring their reindeer to the islands, both for the better pasture which they have to offer and in order that the animals may breed there. Swarms of mosquitoes, also, make life unbearable on the higher inland plains, while the migration allows the moss to grow there during the summer months. Along the shores of the northerly islands, such as Grönö, the steamer passes many isolated encampments, where in small turf huts—with a hole in the roof to let out the smoke—or in tents,

LAPP FAMILY IN CAMP.
The women wear decorated bonnets and plaid shawls, otherwise their costumes resemble those of the men. To picture their full effect the brilliant colours must be imagined. The girl on the right is dressed in winter skins.

the Lapps pass the summer. Their reindeer, which have earlier swum across from the mainland in their herds, now scatter high up the steep face of the mountains overhanging the water, and appear from the steamer like small groups of white ants. These unusual sights emphasized the value of field glasses, which in Norway are as essential to observe such details as they are useful for the general scenery. The valley at Tromsö is every year a centre for a Lapp camp, where a few dozen families make their homes and are a source of much attraction to travellers. Most of the steamers make a halt of some hours, as to reach the camp it is necessary to ferry across the harbour and there take a motor drive.

REINDEER IN SUMMER PASTURES.
At this time of year the Lapps bring the herds down to the coastal valleys, which are in marked contrast to their winter surroundings.

The summer dress of the Lapps—in winter they wear skins and fur—is a jacket of bright blue woollen material, woven and dyed by their native devices. The peaked cap is crowned with a bright red bobble, and round the collar and sleeves there are borders of highly coloured decorations, in red and yellow. The belt carries a hunting knife, and *komager* are worn on the feet—heel-less leather boots with curled up toes—so that the Lapp walks with a flat-footed gait. The breast portion of the jacket above the belt is used as a sack for carrying purposes, and gives the wearer the appearance of being stuffed with a pillow; as he waddles along he resembles nothing so much as a pigeon! The Lapps are a skilful people in their reindeer trade, and many of them acquire considerable wealth. Their status is measured by the number of reindeer possessed—trade being done in meat and skins, while the bones are carved into knives and spoons. The bigger the bobble in the cap, the more wealthy its owner.

A QUAYSIDE PICTURE.
This shows the curious effect produced by the Lapp's practice of using the front of the jacket as a sack. The man on the right is wealthier than his companion, as he wears a larger bobble on the cap.

In Norway the Lapps frequent the Province of Finnmark, paying the usual taxes to the government, and are hence locally called Finns. The Lapps are, however, distinct from the Finnlanders, who reside further eastward in Finnland itself, and their principal territory is Swedish Lapland. The policies pursued by the Norwegian and Swedish governments differ in regard to the Lapps, the former tending towards their assimilation; thus school attendance is now compulsory in Finnmark. How long the people will remain in their primitive condition is therefore a problem which only the future can answer.

Much more might be written about this less familiar part of Norway, which in winter is subjected to the the rigours of the Arctic climate, yet in summer enjoys a pleasant heat and endless sunshine. It would, however, be mistaken to conclude without remarking on the fertile valleys and profuse vegetation which are characteristic of the Norwegian mainland. The coastal steamers penetrate the fjords only so far as is necessary to reach towns that are set back on such waters, but at Trondhjem, for example, a motor excursion may be undertaken through noteworthy inland scenery. The road from there to the Lerfoss waterfalls rises through richly wooded country and on the mountainside near-by, commanding a wide panorama, is now being constructed a modern hotel for tourist and winter sport service.

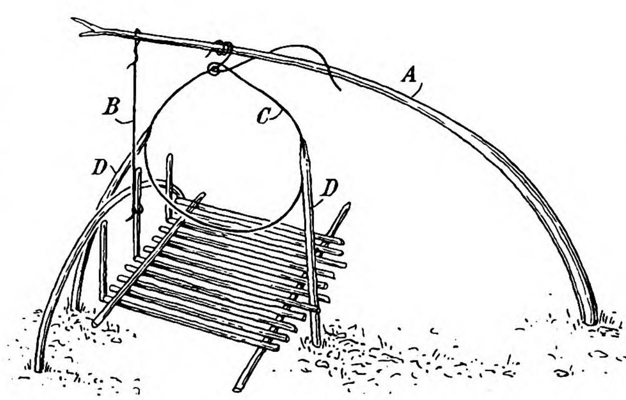
As the traveller leaves the Land of the Midnight Sun and on the southward journey comes again to lowering skies, he appreciates with Wordsworth "the cottage windows blazed through twilight gloom." But his two weeks' journey in perpetual day he will long remember.

A Hunting Tribe of Kenya Colony.

By G. W. B. Huntingford, F.R.A.I.

The Wandorobo are an interesting example of a hunting people now passing into the pastoral and agricultural stages simultaneously. Where the tribe came from is quite unknown, and as they are shy and suspicious of strangers, the writer was fortunate in visiting them under friendly native auspices.

SOME twelve sections of a primitive people, who are generally called Wandorobo or Dorobo, but who call themselves Okiek, are to be found living the life of hunters in various forest regions of Kenya Colony. Of their history, manners, and customs, comparatively little is known; and I count myself very fortunate in that I was able to make friends with an influential Dorobo elder of the section which inhabits the forest region north of Tindiret Hill, some fifty miles east of Lake Victoria (about lat. 0° 5′ N.; long. 35° 25′ E.). This elder was called Kiparngetuny Arap Ng'amng'am, or "Lion-killer son of Ng'amng'am." He was chief of the Dorobo about twenty years ago, but resigned his office, since when they have had no chief at all. I told him that I wanted to see his people—they are very shy, and suspicious of strangers—and he promised to tell them I was coming. The Dorobo country is about thirty miles from where I was stationed recently in Nandi; and one day I started with a friend, the Hon. P. L. O'Brien, on a short expedition to Kipkorom, the nearest Dorobo district. With us went Choimim, the son of Arap Ng'amng'am, and some of my Nandi servants, who have dealings with the Dorobo.



A SNARE MADE OF STICKS.

When the animal treads on the platform the cord B is released, and the stick A springs up, thereby suspending the animal in the attached noose C. This is held open by the split sticks D.

There is no road to Kipkorom, and we walked along native paths. We reached our destination about 3 p.m. after walking for eight hours, and had just time to pitch our tent before a heavy storm soaked everything exposed to it. Some Dorobo had come to meet us, and one of them, a young man named Arap Kimining, volunteered to be our guide. The next day he took us through the forest, about 8,000 feet in altitude, and I met some elders and talked to them. They were inclined to be suspicious at first, but after about an hour's conversation, during which we exchanged some tobacco for milk and honey, they became very friendly, and said we might see everything there was to see. Finally they took us right into the forest, to a group of huts.

The Dorobo build their huts in small clearings in the forest, in groups of two or three, and live in them for about three months, after which time they begin to fall to pieces, and also become full of fleas. They are very rough and comfortless structures, consisting of a framework of sticks stuck in the ground, and bent over, forming a domed roof, on which they tie leafed branches and wild banana leaves, covering the top with a skin to keep out some of the rain. In the middle of the hut is the hearth, and on the far side from the door the people eat and sleep, lying on a pile of skins. Very few tribes in East Africa live in such dreary shelters as these, which keep out neither the cold nor the rain.

The people live by hunting, which until quite recently was their only occupation; a few of them now possess very small herds of cattle—fourteen families living near Londiani own between them forty-five head, while one or two are starting to cultivate. They are thus an interesting example of a hunting people passing into the pastoral and agricultural stages simultaneously. At present the only animals kept in any number are dogs, which are of a different breed from the thin-nosed cur so common in African tribes; they are much fiercer, and are kept in better condition. They wear leather collars with small bells attached to them.

In hunting, the Dorobo use the bow and arrow, and the spear, which are poisoned with a concoction made from the keliot tree (*Acocanthera Schimperi*). The leaves and branches are broken up and boiled

till a thick, pitch-like liquid is obtained, when they strain it and store it in strips of bark, which are kept in the tops of trees out of the way of children. After preparing poison, they remove all traces of it from their bodies with the leaves of a kind of sage. An animal shot with this poison dies in a very short time. The flesh close to the wound is cut out, and the rest of the animal, including the the blood, is eaten. The Dorobo also catch animals in traps, of which they have two kinds. One is an oblong pit dug in the ground, about four feet deep, with wooden spikes at the bottom; across the top are laid thin sticks, and a covering of grass and leaves. The animal falls through the fragile covering, and is impaled. The second kind of trap is more complicated, though it can be set up with a few sticks in an incredibly short time. Some idea of its construction may be gathered from the accompanying sketch, in which details are given of the various parts here described. When the animal treads on the platform, the cord which holds down the main stick is released, and this stick flies up with the noose, thereby suspending the animal off the ground.

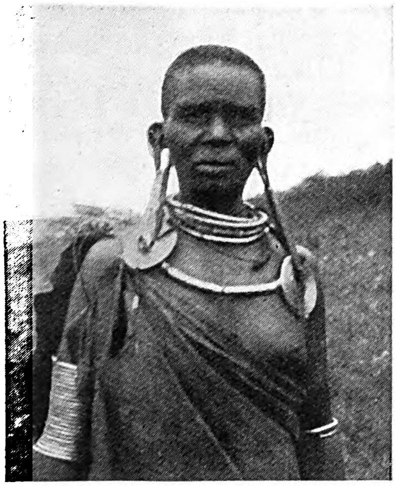
A GROUP OF FOUR OLD MEN.
The native next to the one holding a club is wearing a cap made of the fur of the hyrax or rock-rabbit; these caps are given as part of the price of a wife.

All kinds of animals are hunted, and most animals are eaten, including antelopes, elephant, various monkeys, lion, leopard, pig, and buffalo—in fact, the hyaena is almost the only exception. Of other foods, the Dorobo eat honey, and, when they can get it from the Nandi, a meal prepared from maize and eleusine grain. They also make honey-wine. Bee-hives are made of wooden slats tied together in the form of a barrel, and put in the tops of trees. Each man has his own barrel, and Arap Kimining gave us from his barrel some of the best honey I have ever tasted. When a tree has no branches by which the owners can climb to their barrels, they tie thin poles against the trunk with tree-rope, and climb up by them.

In matters of dress, the Dorobo have more or less copied Nandi fashions. Their clothes are mostly made of skin, though some wear pieces of cheap cotton-cloth dyed brown. The women wear leather skirts and upper garments; married women have large discs of brass wire hung from the lobes of their ears, which, in both men and women, are pierced and elongated. A Dorobo generally has only one wife, as he cannot support more. The price of a wife is as much honey-wine as four women can carry, together with a fur cap for the girl's father. This curious headgear is made from the hyrax or rock-rabbit.

Their arts and crafts are of a very primitive description. They make bows, arrow shafts, and baskets, which are used as currency to buy from the Nandi their iron tools—knives, arrow-heads, etc., a manufacture of which the Dorobo have no knowledge—and tobacco, beads, and pottery.

The Dorobo have a vague belief in a god, called Asis, who is the sun and masculine, and who has a sister, Arawa, the

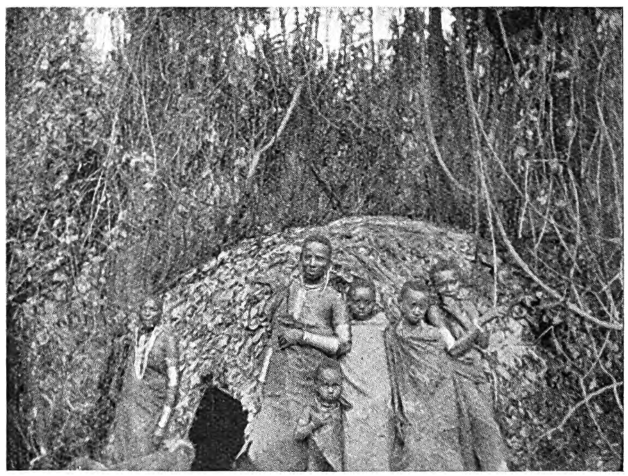


THE MARRIED STATE.
This old woman is wearing the discs of brass wire that among the Dorobo denote the marriage state.

EAR STRETCHING.
The blocks of wood in the lobes of the ears are put in to stretch them. The hair is closely clipped.

moon. They do not make offerings to them, but before going to hunt, the men pray to them, saying, "O Sun (or Moon), fill us with food." They believe in a future life, and say that after death the soul goes to Spirit-land, which is under the earth and a bad place. The spirits there may be good or bad in their intentions towards mankind; the good spirits are those of their ancestors, and to them offerings are made of honey-wine and water, which are poured on the ground, with the prayer, "O Spirits, fill us with food, that we may be filled with health." No offerings are made to the bad spirits. At death, a person's body is carried out into the forest, and left for the hyaenas to devour. There are also magicians, who are all bad, and who by their spells prevent people from getting food.

Where the Dorobo came from is quite unknown. It seems probable, however, that they are a more or less aboriginal people, who were living in the country when the Nandi and Masai came into it. They say themselves that they have always lived here. "The Masai came on one side of us, and the Nandi on the other. We do not know anything else." The Nandi have a curious story about the beginning of the world, to the effect that when God came to "prepare" the world, he found three things living on it—an elephant, the thunder, and a Dorobo. The elephant and the thunder were both afraid of the Dorobo, because he could turn himself over when asleep without getting up first. The thunder said, "I am afraid of this man; I am going to live in the sky," and he went, while the elephant laughed at him, saying, "This man is a little creature—he is nothing." The Dorobo said, "I am glad the thunder has gone; I was afraid of him; I do not fear the elephant." And he made poison, and shot the elephant. And the elephant, dying, called out to the thunder to take him to the sky; but the thunder said, "No; you laughed at me when I said the Dorobo was dangerous. Die by yourself." And the elephant died; and the Dorobo became lord of all the earth.



A NATIVE HUT IN THE FOREST.
Such structures consist of branches covered with wild banana leaves and they quickly fall to pieces. Fleas also soon make them uninhabitable.

A somewhat similar Masai story has an elephant and a snake, both of which are killed by a Dorobo; it goes on to say that God told the Dorobo to come to a certain place early in the morning, as he had something to tell him. But a Masai who was hiding behind a bush and heard, went ahead of the Dorobo, and God let down a rope from heaven, by which descended to the earth a great many cattle. The Masai exclaimed in surprise, whereupon the cattle ceased descending, and God said, "You shall have no more, because you were surprised." And the cattle wandered off, and became mingled with those of the Dorobo, who could not tell his own apart. So the legend runs that the Masai took possession of them all, and from that day to this, the Dorobo have been savages with no cattle, and have had to hunt for their food.

As we were passing through the Tindiret district on the way up to visit the Dorobo, we were much puzzled one night, when near Kipkorom, by a wailing noise which came from the forest. This noise resembled the whistle of a Uganda railway locomotive, or a native wooden pipe. It cannot have been either of these, however, because the railway is too far distant for one to hear an engine; and it went on all through the night at intervals, one stretch lasting about half an hour. The Dorobo said they knew nothing about it; and a Nandi who had lived in that region when a child told me that it was the devils (*chemosisiek*). Chemosit is the Nandi devil with one leg and a mouth which shines like a lamp; it wanders about at night looking for children to eat, whom it entices by its singing.

I suggest that some perfectly harmless animal is the origin of this devil, for I once saw at night a small creature, probably a squirrel, which showed but one eye, and bobbing up and down as the creature moved its head this gave an impression of something hopping on one leg.

The legends and beliefs are full of interest; but the development of the Dorobo from a hunting to a pastoral and agricultural existence is their most noteworthy characteristic for future study.

Bird-counting from the Train.

By E. M. Nicholson.

Author of "Birds in England," etc.

The novel experiment of counting birds from the train would at first sight seem doomed to failure, but experience has proved otherwise. The figures obtained are incidentally of interest in regard to bird protection, which is usually obscured by fallacious beliefs.

DURING July and August a year ago, at the time of the Alpine bird census already described,* I was travelling a good deal about Europe between Italy and Ireland, and on these journeys I amused myself by counting from the train all birds seen on one side of the line over definite sections of the route. Although in the absence of better material such a count is by no means without value, the errors inseparable from the method are obvious enough, and the result is not to be called a bird census. One is hardly likely to do justice to the titmice or warblers from a moving train, and the abundance of birds large or conspicuous in plumage or in habits, must tend to be exaggerated at the expense of the remainder. Identification will be more difficult, and frequently out of the question, especially in countries where birds are not all of familiar kinds. To an observer like myself, who relies at least as much on the ear as on the eye, the noise is a serious handicap—more serious, actually, than the vibration, which forbids the use of field-glasses. There is the further question how far the course of a railway is typical of the country it penetrates, since it necessarily includes the smallest possible proportion of hills and the largest of towns and valleys. Such limitations are plain, but there is one redeeming feature. They apply with equal force to the railways of every country, and do not therefore affect the cardinal requirement of a census—that its results shall be comparable with others. If small birds escape notice in England, they escape it as readily in France, so that while absolute figures are out of the question one may hope to obtain a serviceable denominator.

Tunnels and Woods.

There remain two disturbing factors to be borne in mind. One is the length and frequency of tunnels, deep cuttings, and densely wooded country, which severely restrict the field of view and consequently the number of birds distinguishable. Where these did not occur commonly enough to have a very serious effect they were ignored; where the length of such blind sections became appreciable, as in the much-tunnelled climb to the Mont Cenis, they were roughly measured and deducted from the mileage covered. Where we ran unexpectedly into forests, which cannot usefully be dealt with in this way, the census was simply closed down from the last previous station. This was rendered possible by drawing a line after every few stations, or wherever the character of the landscape altered, and thus keeping the figures for the various sections distinct. It is impossible to break off between stations, because then the distance covered is unknown; otherwise it can be read off afterwards from any good time-table. Naturally, a count is almost useless without some sort of data regarding the amount of ground covered.

The Speed Factor.

The other factor is, of course, the speed of the train. How far this affects the results depends on the observer; in my own case the degree of accuracy seemed to remain substantially the same up to thirty or thirty-five miles an hour and after that to fall off rapidly, till above fifty it was hardly worth continuing unless the country was exceptionally open. In England, where the expresses go fast for really long distances, this may give serious trouble; but abroad and in Ireland, where bursts of high speed generally alternate with stretches of slow going, I did not find much difficulty from it. A stopping train naturally gathers most moss, for at each halt the songs of small birds and their elusive forms become more easily distinguishable; but only the Italian and Bavarian counts were taken under these favourable conditions. Whatever speed bias exists is therefore in favour of these and against the French and English results, the Welsh and Irish being in this respect nearer the average. A not unimportant point is the post of observation. Naturally the view ought to be as little restricted as possible; the corridor or a corner seat facing the engine is the best usually obtainable, but in Bavaria I discovered the ideal in the open front platform of a 4th-class carriage, fenced simply by an iron grill hardly breast high—no glass, no bars, and nothing to limit vision except the coach in front.

* "A Bird Census in the French Alps." By E. M. Nicholson. *Discovery*, Part I, November; Part II, December, 1926.

As the data obtained are too numerous to print in full here, it will serve instead to comment on the points they bring out, summing them up as we go. It would be absurd to claim that any number of such counts, much less this handful, can serve as an analysis of the avifauna of different regions. But in the complete absence of data from most parts of Europe they may serve as soundings, taken haphazard, to help to indicate certain salient features, particularly of the composition of bird population, and even, perhaps, of its relative abundance. Thus the strength of birds so important in economics and in Nature as the rook, starling, magpie, and kestrel, may be ascertained with fair success even by a count from the train.

Rooks and Starlings.

We find, for example, that in England about 38½% out of 610 birds noted in this way are rooks; in North Wales also 38½% out of 200; across Ireland about 36% out of 1,419; and in Normandy about 57% out of 632; while in the extreme west of Ireland (Connemara) the rook claims only about 1⅔%, and in all the German, Italian, and French (south of Paris) counts, its place is at least as humble, where it has any place at all. Here we have an incontestable example of a species dominant over a large area suddenly ceasing to play much part in the ecological scheme outside it. It would be roughly correct to say that between Galway and Paris the rook counts for considerably more than beyond those two points.

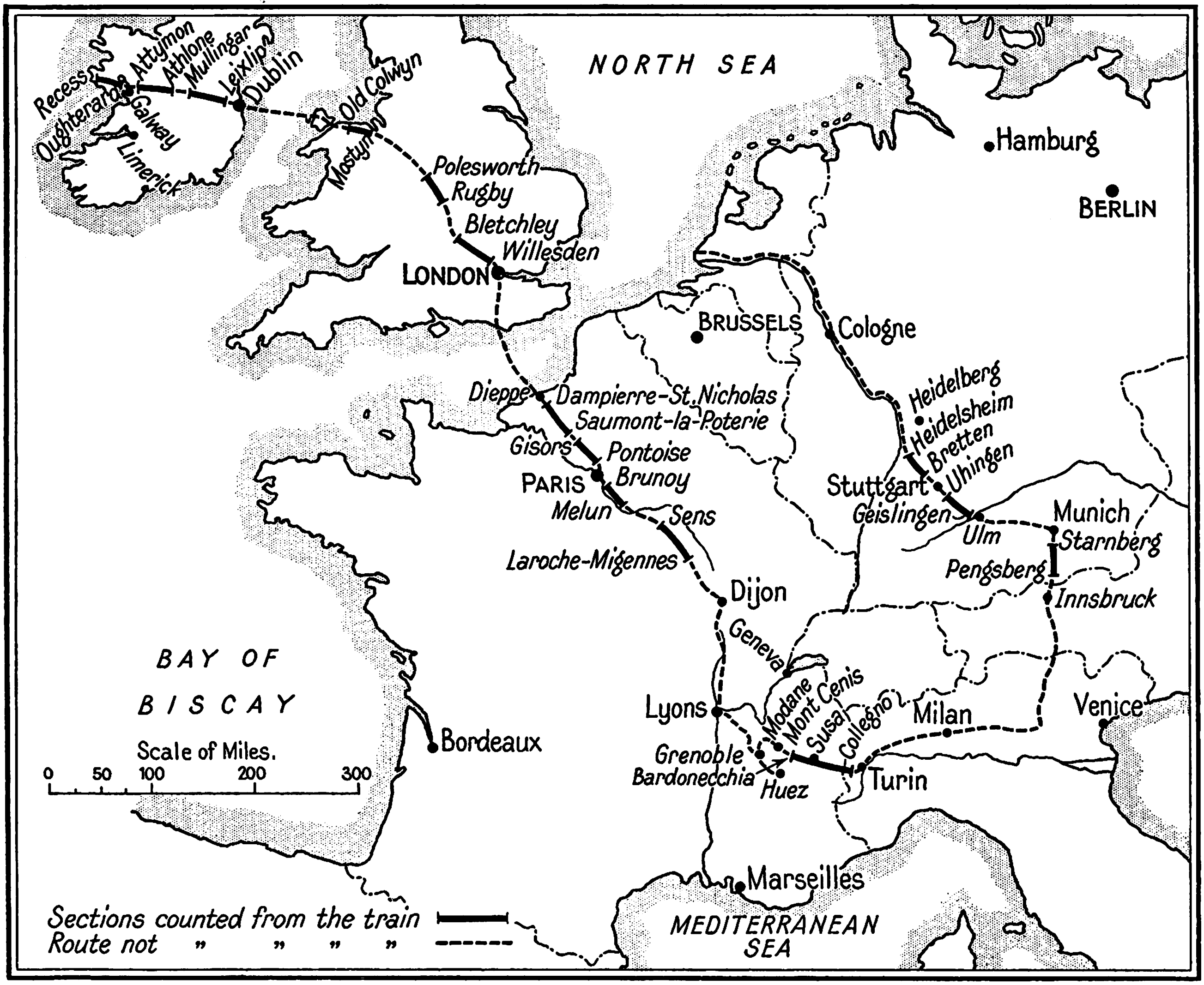
The starling, although everywhere more concentrated, makes a fairly similar appearance in the counts, so far as they go. It is strongest in North Wales with about 36%, and in the English Midlands with about 24½%. In the eastern half of Ireland it still has about 20½%, but after Westmeath there is a sudden failure of entries, and out of 467 birds seen along forty-eight and a half miles of track farther west in Ireland not one was a starling. (I am not, of course, suggesting that the starling does not occur west of Athlone—it undoubtedly does—but the arbitrary and not untypical cross-section drawn by the west-bound mail showed rather strikingly that at least in August the distribution of numbers between east and west cannot be anything like equal.) And although it drops out earlier than the rook as one goes north-west in the opposite direction, the starling remains longer an important member of the fauna. In the French totals south of Paris it still shows 20.4%, and in a small strip of Wurttemberg two separate flocks raise it actually to 67½%, although farther south in Germany it grows rare, and in Italy it altogether fails.

It is commonly believed that the Latin countries have next to no birds left, and in particular that they have killed off all their swallows and martins, and are a menace to ours on their migrations. While such a summary count gives no ground for being dogmatic, it appears to me that both Italy and France come out surprisingly well, if we assume that the sections by which they and other countries are represented are anywhere near typical. In Italy out of 426 birds about 12% were swallows, although a large part of the route was unfavourable to their presence; the Plain of Piedmont had 24%. In France the percentages of swallows in the two summer samples were very uniform at about 24% and 26%, averaging 25.22% for the whole. In southern Germany, where the people are much more friendly to birds, swallows (which from the nature of their haunts must be very sensitive on that score) amounted to just over 35% of 410 birds noted. This was due principally, however, to a single section where they rose to 59%; in another they represented only 4.75%, and in the third 13.5%. But in England, where killing a swallow is almost unheard of, the highest proportion recorded for any section was under 6% and the general average about 2.8%, while in North Wales it was only 1%.

A Conclusion Confirmed.

Two years ago, in my book *Birds in England*, I had commented on the comparative abundance of swallows in Ireland, and this was borne out by the figures obtained—7% in the eastern half, about 5.5% in the western, and about 15% in Connemara. Perhaps a more reliable absolute criterion is afforded by the number of swallows seen per mile of count, which works out at about 0.25 in England, 0.1 in Wales, 1.19 in Ireland, 1.8 in France, 1.05 in Italy, and 3.4 in Germany. (Swifts, which averaged about 0.95 per mile in Germany and nearly 3 per mile in Italy had, alone among the species affected, already migrated before the remaining countries were visited, and no comparison was therefore possible. Their departure may have appreciably reduced the French and British totals as against the German and Italian.)

These data fail to sustain the common English opinion that Latin Europe has succeeded in exterminating its own swallows and a good many of ours into the bargain. They show, on the contrary, exactly what a naturalist would expect; that the relative numbers of the swallow tend to decline towards the northern and eastern limits of its range, and to increase towards the warmer parts, or those where insects flourish most. It seems likely that the higher



MAP OF WESTERN EUROPE SHOWING SECTIONS COUNTED FOR BIRDS.

percentage recorded in Germany may reflect some real advantage gained from protection, the power of which to increase numbers is undoubted; on the other hand, no ordinary persecution can reduce an important species far below its natural level in the balanced fauna unless there is some other capable of superseding it. Every count was made when the first broods were strong on the wing. It might be argued that southward movement affected the results, but in the Dauphiné Alps I watched carefully for migration and could find no trace of it until August, some time after the southern counts had been secured. That there was a certain amount of leakage before the English counts in mid-August is more plausible, but the Irish counts were the latest of all obtained, and they showed a larger crude number of swallows than any except the South German. The only count in which I found definite ground for suspicion was the French, which may have gained by immigration, though the suspicion does not seem to me a serious one.

The swallow, being conspicuous, instantly recognizable, and always in flight, makes an ideal subject for counting from the train. That the results obtained are reliable so far as they go is confirmed by analysis. Coming up from the Plain of Piedmont to the Mount Cenis I divided operations into three sections, the first being a stretch of plain from Collegno by Turin to St. Ambrogio, the second an upland valley from thence to Meana, and the third a really mountainous section to the high frontier village of Bardonnecchia. On analysing the figures for these three sections we find a striking contrast in their composition. The swallow, which had 24% in the plain, fell to 12% in the hills and *nil* in the mountains; on the other hand, the swift rose from *nil* for the plain to 9% for

the hills and no less than 80% for the mountains:—

PERCENTAGES OF TOTAL CENSUS.

Bird	Plain Section	Hill Section	Mountain Section
Swallow	c. 24	c. 12	0
Swift	0	c. 9	c. 80
Italian Sparrow ...	c. 50	c. 65	c. 6
Small birds, *Species* ?	20	c. 8	c. 1.4
All others	c. 6	c. 6	c. 12.6
	100	100	100

In addition to the very large numbers of Italian sparrows recognized as such, a very considerable number of the "small birds unidentified" must certainly have belonged to this species; I should put the real numbers at 60% for the plain and 70% for the hills, dropping sharply to 6% for the mountains. If in the light of these striking figures we examine the German results we find the same tendency at work. The Heidelsheim-Bretten section on the fringe of the Rhine levels has about 13.5% of swallows and only 1.5% of swifts, but the other side of Stuttgart, in the Black Forest hill-country towards Ulm, the positions are reversed with 4.75% of swallows and *c.* 44% of swifts. At the upper end of the Starnberg-Pengsberg section the same thing was coming out when the count had to be broken off. Even in so high a latitude as ours one sees the preponderance of the swift growing with increasing altitude, although towns and several factors complicate distribution.

General Results.

Apart from the German figures, the results here discussed form a summary and much interrupted cross-section across Europe north-west and south-east from the Atlantic almost to the Mediterranean. The sameness of bird life thus illustrated is almost depressing. Although 3,353 individual birds were included in the July-August counts, the number of identified species was only about forty, and a handful of forms are overwhelmingly strong compared with all the rest, as the following table shows:—

Bird	Number	Approx. Percentage of Whole.
Rook	840	25
Swallow	375	11
Starling	568	17
Black-headed Gull	242	7
Sparrow (counting the house and Italian forms as one) ...	221	6.5
Swift	176	5
Lapwing	146	About 4

Thus the three strongest species outnumber all the rest put together, and the first half-dozen make up three-quarters of the combined totals. Naturally in this direction bird-counting from the train gives only a caricature of the true state of affairs, but a caricature is, after all, an intensification and analysis of salient features.

The choice of sections was not haphazard; although it was impossible to keep up indefinitely the strain of accurate counting, I was constantly observing and was able to form a good idea of the numbers of birds over long distances where no actual count was kept. All the counts taken were fair samples of much larger areas traversed, with the exception of the second French section (Melun-Brunoy), where the speed must have averaged sixty miles per hour and had a bad effect on the results, and the Irish section, which was more than a sample since it covered about half the distance from the Irish Sea to the Atlantic. The North Wales results, however, were typical only of the coast, which is followed by the Holyhead main line and has a much denser bird population than the hinterland. In order to make the results strictly comparable they were taken as early as possible in the morning; only the Bavarian count was compiled during the afternoon. In southern Europe the difference between the bird life visible say at 6 or 7 a.m. and at 2 p.m. is colossal. I suspect that this is one of the main reasons why Italy, France, and Spain are credited with a poverty of bird life which the counts did not confirm. Naturally the Englishman on the Riviera or in Italy sees far fewer birds about, and hears less song, than he would at home in the middle of the day. That does not necessarily mean that the birds have been slain, but quite possibly that he gets up too late in the morning. If I had made a count across Lombardy in the heat of the day I would certainly have come to the conventional conclusion that Italy has no birds.

An Italian Adventure.

During the Italian count an amusing thing happened. Towards the frontier at Bardonnecchia some emissaries of Mussolini came along the train and found me so intent on my count that I did not at first realize their presence; bursting with suspicion they ringed me round, and snatched away the list, poring over it in an endeavour to connect it with some imaginary scheme of espionage. They interrogated me very sternly, but I was too much amused to attempt an explanation, and failing to find further proof they reluctantly let me have my papers back.

We may, then, take the results for what they are worth, and try to compare the bird population of the countries represented. Ireland stands out with

an average of 16.89 birds per mile, maintained over the impressive distance of eighty-seven and a half miles. But on examining this figure more closely we find an astonishing cleavage between Ireland east of the Shannon valley, with a census of 1,280 birds on forty-six miles, or 27.8 to the mile, and Ireland west of the Shannon valley, with a census of 198 on forty-one and a half miles, or 4.77 per mile. The main line to Galway and Connemara goes right across the middle of Ireland; divide it into halves and the eastern gives a census between three and four times as great as corresponding distances in Germany, England, and Italy, while the western gives considerably the lowest total in its class. Roughly speaking, the sparse population belongs to the peat moors and the dense population to open parkland and tillage. It is a dry peaty area between Moyvalley and Killucan which forces the average for that section of the eastern half down to 4.35 per mile, when none of the four nearest it fall below 24. The four highest July-August sectional averages were all east and central Irish, and four of the five lowest were west or central Irish also.

Extreme Sections.

As the Irish section averaged only eight and three-quarter miles long, while the rest (except the Welsh) were all fourteen to sixteen and a half, this is partly a statistical difference; but when I corrected that by linking every one with the one after it, Ireland still had five of the dozen most extreme sections with a minimum length of twelve miles, and these included both the highest and the lowest.

Wales, with 10.5 per mile, comes second, but this, as I have explained, is the favoured coastal belt and not typical. Germany has 9.65; England 9.4; and Italy 9.06—a curiously close bunch. No doubt the fact that so many English birds are small and hedge dwellers tells against them in this sort of cursory count. That the French average was only seven I attributed to the long stretch attempted at a faster rate than any of the others; the only section taken under comparable conditions came out at 9.32 birds per mile. In January, 1928, I had an opportunity to put that suspicion to the test by a further count from the Dieppe boat train—about twenty-five miles from Pontoise to Gisors and about thirty from Saumont-la-Poterie to Dampierre-St-Nicolas. This brought the total of French track covered up to eighty-seven and a half, the number of birds amounting to 861 (9.8 per mile) compared with 1,478 in Ireland on the same distance

The dominant rook (528 or *c.* 36% in Ireland; 266 or *c.* 30.8% in France), and the starling (207 or *c.* 14% in Ireland; 122 or *c.* 14.6% in France), made up surprisingly similar proportions of the totals. Except in the case of the rook, where they have been inserted, these January counts are not included in the foregoing comments, which refer to summer totals only. But the winter population of areas not seriously exposed compares as a rule quite well with the breeding stock, and it would be difficult to assert that any error there may be through treating these as comparable is likely to be in favour of France. The danger of thus using a higher figure than would have been obtained in August seems slight, for the weather in this region had just been extremely severe. I see no reason to doubt that these results, which put France in the same class for bird population as England, Germany, and Italy, are substantially correct so far as they go; the question how far our hedges raise our aggregate is, of course, outside their scope.

I know from a proper census that over large areas the type of English Midland country, which comes out at 9.4 per mile, has an actual bird population of between two and four to the acre; from this it looks as if large areas elsewhere in Europe may fall not far short of this density, although, of course, they are often inferior in the important item of cover, which tends to make our own bird population come out less favourably than it should by this method.

Bird Protection?

The cardinal merit of a bird census is not to compile statistics for pedantic use; it is to bring out things which are obvious enough once distinguished, but incapable of being learnt by the ordinary observer in any other way. The haphazard figures obtained, which are of no absolute value whatever, may, I believe, help to give perspective where it is badly needed; to show how uniform the bird life of Europe is over wide areas, and how grudgingly one dominant species yields place to another. They may also help to din in the first lesson which bird protection has to master, that bird populations of similar areas under similar conditions will be similar, whether the inhabitants persecute them or not. The difference between protection and persecution is not a difference between presence and absence of birds, and it is not essentially a question of numbers, although other things being equal a species will certainly be commoner where it is adequately protected. The main change which protection can effect is a growing confidence of birds towards man; so long as the issue is obscured by fallacious beliefs about numbers, little progress in that direction is likely to be made.

Two Rarely-Visited Egyptian Temples.

By G. A. Gardner.

As a member of an expedition which was working there under the auspices of the Royal Anthropological Institute, Captain Gardner visited two remarkable ruined temples in the northern Fayum desert.

NUMEROUS peoples of all nationalities congregate in Egypt during the winter months, and no doubt visit during their stay most of the recognized and famous monuments of antiquity—the Pyramids of Gizeh, Sakkara, Luxor, and a host of other places as well known to the travelling public, as, shall we say, the Riviera; but how many, I wonder, of the general sightseeing crowd have ever heard of, much less seen, the small so-called XIIth Dynasty Temple of Qasr-es-Sagha, or the very large Ptolemaic one of Dimê? It is my intention to give a brief account of these two interesting places, for owing to their inaccessibility very few Europeans have ever seen them, and nothing much is really known about either. To begin with both lie off the beaten track, right out in the desert near the Fayum Oasis and some forty or fifty miles from Cairo; no roads nor even tracks exist, so a motor-car in very good pulling condition is essential. The Egyptian State Railways run a good service to Medinet el Fayum, and from there a light railway can be taken to the village of Tamieh, which is the nearest point in the cultivation, on the eastern side, to the ruins. It is, however, advisable to arrange for motor transport at Fayum itself and to take a guide, if possible, from there, but it is absolutely essential to have a trustworthy car of good qualities, for as will be seen the journey across the desert is exceptionally trying and the going is at times appalling, and very few of the ordinary Arab taxis can be trusted to go ten miles without breaking down.

THE INNER SHRINE AT DIMÈ.
This temple encloses a rectangle 300 by 200 feet in area, and some of the ruined walls are over 40 feet high.

As I was particularly anxious to inspect these two sites, a day was decided upon for the visit, and we left our camp very early in the morning carrying with us ample supplies of food and water, not omitting extra petrol and oil for the car.

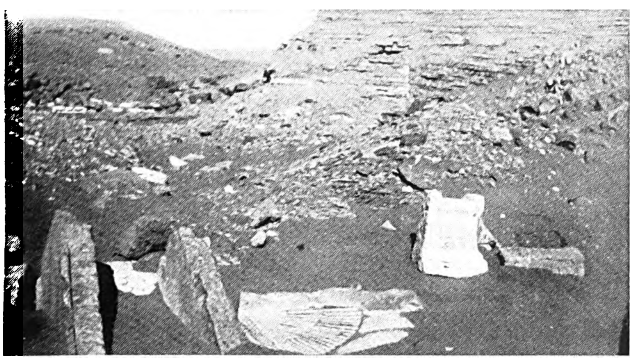
For the first five or ten miles the going was not at all bad, as we kept as far as possible to the limestone scarps and ridges, but occasionally belts of thick sand had to be negotiated, through which the car crawled on reduction gear. The views obtained from these ridges during the early hours of the morning are exceptionally fine, as they are something so completely out of the ordinary. Vast waves of desolate country, dotted sparsely here and there with small scrub-like bushes—stretch down on either side; to the north-west tower a long line of red frowning cliffs appearing like a series of huge terraces, and which we are gradually approaching. Every now and then we catch glimpses of the lake Birket Qarun shimmering in the morning light below us. All too soon we leave our limestone scarp and descend a long gradual slope that brings us to a huge depression thickly carpeted with the detestable sand. Here one of my companions, who knew this part of the desert well, asked me if I could pick out the Temple of Qasr-es-Sagha which lay just before us on the cliff. Try as I would, however, I could see no signs of any building, the same red tone pervading all the rocks, and as the sun was now getting higher everything appeared one blend of colour with no distinct and visible detail. Finally the temple was pointed out to me, surprisingly camouflaged, as its colour was the colour of the cliffs and all the surrounding hills, and only the small dark patch of the open doorway showed black against the general reddish tinge of the whole neighbourhood.

We ploughed through the thick sand covering the floor of the valley, and after many twists and turns

crept up the sandy wady leading to the temple itself. Here we left the car and made the rest of the way on foot, until finally we came out on the platform or terrace on which the building is erected.

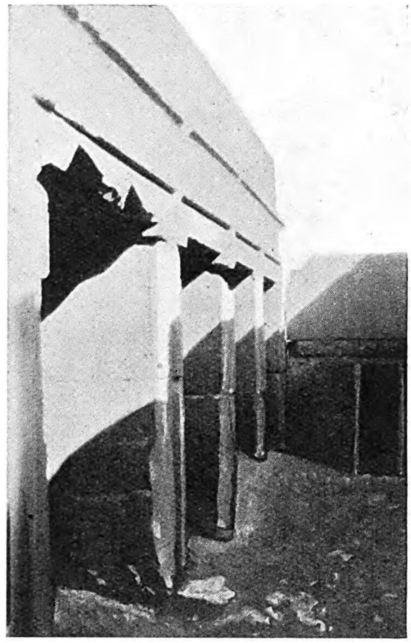
There it stood before us—small, weather-beaten, unknown, and almost forgotten. By whom it was built and why we do not know. No hieroglyphics on its walls tell us its past history; no writing or graffiti of any sort have ever been discovered to tell us what Pharaoh of perhaps the XIIth or even much earlier Dynasty erected this lonely mortuary chapel in a spot so desolate and far from human surroundings. Perhaps the old builder himself lies buried in those red cliffs that tower up terrace upon terrace behind his forgotten sanctuary, and sleeps there secure in the knowledge that his resting place is never likely to be disturbed by the curious hands of man.

As I have stated, the temple is a small one, perfectly plain with no hieroglyphics nor sculptures of any sort, only a large bead or moulding runs around the tops and down the front panels of the seven small cell-like chambers, the sole ornamentation in the place. The building itself is rectangular, 80 feet by 29 feet, and consists of a narrow central hall or passageway, off which run the seven nitch-like recesses, but what their use was it is impossible now to say. The temple is built of immense limestone blocks, laid and fitted carefully without mortar. So close in fact are the joints that it is impossible to insert a needle between the stones. The masonry may be termed "cyclopean," as the majority of the blocks are enormous, one measured being 8 feet by 6 feet by 30 inches, while the huge inner door lintels are all formed from single pieces of limestone of great size. It is curious to observe how the ancient masons shaped the different blocks to fit one to the other, some being bevelled, others notched out, and no time or trouble was spared to get an accurate joint and to preserve an even face without gaps in the wall.



THE SACRED SYMBOL OF THE SUN.
Near the small altar is seen a partially buried stone, carved with the sacred winged symbol of the sun.

How these colossal masses were lifted and fitted is a puzzle, but the engineering skill displayed and the extreme accuracy of the proportions of the building denote a constructional skill of the very highest order. In the thickness of the front wall is a passage, its purpose being also a mystery, but a spyhole looking out into the main entrance seems to point to its use for the purpose of enabling the old priests to observe the incomers without themselves being seen.



THE QUASR-ES-SAGHA TEMPLE.
View showing the inside walls.

The terrible effects of sand and wind erosion are well seen at Quasr-es-Sagha, the huge blocks being literally eaten away and undercut by the corrosive action of the wind-blown sand. This is particularly noticeable on the northern face, as the prevalent winds blow from that direction, and it is quite clear that unless the authorities take some steps towards its restoration or preservation that before very long this interesting and unique temple will be nothing more than a mere tumbled heap of ruins.

I think the general impression it gave me was one of forlornness; poor lonely little temple standing neglected on its rocky ledge, forgotten alike by gods and men, for how much longer will it stand gazing out over the ever-changing desert sands? Not much longer, I fear, unless pity be taken upon it.

Our brief inspection having been completed we returned to the car and reversing it, not without some difficulty, made our way down the wady and back to the sandy depression at the cliffs' foot. Alternating patches of thick sand and moderate going enabled us to make further progress west at a reasonable rate, until we struck a patch of country the like of which it has never been my lot to travel over. I have motored over several countries, including some of the alleged roads in South Africa, but never before have I encountered such a chaotic confusion of tumbled rocks and boulders of all shapes and sizes. At first glance one would consider it impossible for any wheeled

vehicle, except perhaps an ox wagon, to negotiate such country; but we went straight for it and zigzagged between and sometimes over jagged limestone slabs of terrifying proportions, slid and bumped down gullies, crept slowly up the opposite face, and finally (when I had begun to reflect that there could not be a tight bolt left in our trusty six-wheeler, we arrived at the foot of an enormous mound, and I knew that our destination had been reached at last.

Dimê, Dimei or Dimay—spelt in several ways, as the Arabian language allows the greatest latitude as regards its vowels, but the consonants must be rigidly

LOOKING DOWN THE DIMÊ CAUSEWAY.
Here the temple is seen flanking a paved causeway four hundred yards in length, and terminating in a pair of steps at the desert edge.

adhered to—occupies a long ovate mound on the northern end of which the great temple is situated. A sandy track strewn with the remnants of broken pottery leads up to what was formerly the northern entrance, and passing through the crumbling ruins we enter the vast courtyard of the sanctuary. What a scene! To those who knew the shell-torn buildings of Flanders the broken walls of Dimê will seem oddly familiar. We have the heaps of tumbled bricks, smashed and battered stones, crazy walls fantastically set at impossible angles and, in fact, the whole aspect of the place is that of a building torn and riven asunder by some titanic convulsion.

In spite, however, of the destruction and consequent chaotic state of affairs, the general plan or idea of the place can be distinguished. Mighty walls of sun-dried brick still towering in places 40 feet high enclose an enormous rectangle 300 feet by 200 feet. The construction of these walls is peculiar, but typical of Ptolemaic buildings of the same material throughout Egypt. They are approximately 8 or 9 feet thick at the base, but taper gradually upwards to perhaps 5 or 6 feet. They were for some extraordinary reason built in large sections, each block being quite distinct and not bonded into its neighbour, a totally wrong principal in brick laying. Through some cause or other the centre courses have sagged to a great extent, presenting the curious spectacle of many large segments of circles running from section to section in the fashion of an immense number of loops. Traces of a passage in the thickness of the wall enabled the priests to make a circuit of the building without descending to the ground, and to see and hear without being seen or heard.

Directly in front of us as we stand at the north gate lie a heap of ruins, the truncated columns of a building emerging above the general debris. This, to judge from the scattered fragments of well worked stone, from a small altar and from a block with the sacred winged symbol of the sun carved on it, was the first shrine or fane of the temple proper. This is the first portion of a series of large structures that occupy the centre of the court, and run from the northern entrance to near the southern.

To the rear of the first shrine, and probably connected to it, is a bewildering number of apartments built of coarse rubble, which in its pristine state had been plastered inside and out with a hard cement coating. The rooms therein are small, and it is not known for what purpose they were intended.

The southern portal of this group is constructed of well-dressed limestone blocks, tastefully moulded and champhered, and must have presented an imposing appearance in its original state. Leaving this entrance we stand once more in the courtyard, the southern doorway of the temple immediately before us. There had been formerly a range of rooms close to the main walls, but except for a small group in the north-west corner all these have been practically destroyed, and a large amount of spadework is necessary to make their plan and purpose clear.

The "Sacred Way."

As we pass through the gaping hole where once stood the southern gate of the temple, a broad causeway in quite a tolerable state of preservation slopes gently down before us. Paved with large slabs of stone it runs south for about 400 yards, terminating in a pair of steps at the desert's edge. This was beyond question the "Sacred Way" so common to Greek temples in general, and along which in times long past the worshippers of the old gods made their way to offer incense and sacrifice to the deities of an age long gone by. The ruins of well-built houses are to be seen on either side of the causeway, and one cannot help feeling that all is part of an original and preconceived plan, for many large ancient Egyptian temples were an entirely self-contained community, weaving their own cloth, baking their own bread,

fashioning their own pottery, and so forth. From the similarity of structure, their regular plan, and absence of all erratic distribution, the temple and its environs at Dimê appear to have been such a community.

It is said that Isis was worshipped here and also Sobek, the god to whom the crocodile was sacred, but no inscriptions are visible and much work has to be done before the history of the shrine is made clear. Unfortunately, some fifty to sixty years ago, when the interest in ancient buildings was not so great as at present, the powers that were then in the land allowed a contractor for "Sabakh," a fertile earth containing salts and obtained from ancient sites, to use the spot as a vast quarry; and more damage and destruction was wrought in the short time during which the contract was in force than was ever effected by the hand of man previously or by the erosive action of the desert winds.

Dimê was called by the ancients "Soknopaiou Nesos," and very much like an island it must have appeared when nearly surrounded by the floods of the irrigation, for an extensive canal system recently discovered affords proof that much land that is now under desert conditions was formerly cultivated and inhabited during the prosperous reigns of the early Ptolemies. Under their degenerate descendants, however, or perhaps even much later, the desert, always lying in wait, reclaimed its own, and where once were fair fields and pastures the yellow sands now reign supreme.

Desolation.

Nothing, I think, that I have ever seen affords such a complete picture of desolation as Dimê. One is awed and oppressed by its immensity and the complete absence of all active life. As I stood by the desecrated shrine shortly before sundown, there was not a breath of wind, no note of bird or beast broke the deathly stillness of it all; and as the long shadows cast by the ruined walls began to creep over the ancient courtyard one could well imagine the awe and terror in which the natives held this place, and even feel the spirit of Isis brooding over her ruined fane, or fancy the horrid vision of Sobek, hovering black and menacing, lurking in the shadows. *Ave atque vale.*

It was, however, well worth the time and trouble to have seen this interesting and lonely ruin, and it is to be hoped that money will be forthcoming for its complete and scientific excavation, for within its crumbling walls much may be learned concerning this fascinating and debatable land—the Fayum.

Correspondence.

IS THERE A SURPLUS MALE BIRD POPULATION?

To the Editor of DISCOVERY.

SIR,

Your contributor, Mr. E. M. Nicholson, whose book "How Birds Live" was reviewed in your columns, deals in the Third Appendix with the problems of mapping out bird territory on the basis of bird song, and warns against assuming that every singing bird represents a pair, "because many of the cocks that sing the loudest and the longest through the nesting season are mateless birds." This opens up a very interesting question and has given me the clue to the interpretation of certain facts

UNMATED GREAT SKUAS, SHETLANDS.

which have puzzled me not a little in recent years when observing birds in the breeding season. Is there a surplus male bird population? If so, are there more males than females born, or is the mortality among the females greater? I cannot pretend to answer the latter, but some observations of mine may throw some light on the former question.

I have for the last three years in April, May and June observed the warblers in an area of about 100 acres of oak and hazel coppice (G 12, G 13 and G 14 in Mr. Nicholson's classification of types of country), interspersed with meadows and pasture (H 1 and H 2). I have found that regularly each year five or six cock nightingales arrive and sing until the middle of June. But after careful searching of the area I am never able to find more than one, or at the utmost two, nests. Moreover, after the middle of June, careful watching cannot reveal more than one or two broods of young which have left the nest. On the other hand, the cocks that do not appear to be mated sing perhaps a week longer than those that have broods, but soon after the middle of June cease singing too. Now the area of my observations is on the most extreme westerly limit of the nightingale's distribution, namely in the western end of the Severn valley. So far as I know, they never occur in the valley of the Wye and surrounding regions. Is it possible that the cock nightingales, as they enter the country at the south-east corner in Kent and Sussex, spread northwestwards to their usual limits and that the hens, coming some ten days later and being less in numbers, do not reach the outer marches of the nightingale territory in sufficient numbers to mate with all the cocks who have occupied territory there? If this is so, it postulates an excess of male population.

I suspect a similar state of affairs among the willow wren and

chiffchaff population of this area. I have for the last three years found the nests of both these species within about thirty yards of the same spot each season. Cock birds take up their vantage posts and carve out territory which seems to be always the same. But there are some singing cocks outside the area occupied by the nesting pairs which seem to have no mates, or at least I can see none and careful search of the hedgerows and long grass reveals no nests.

Going now to a quite different region, I had occasion to watch this summer the colony of the great and Richardson's skuas at Hermaness in the Shetlands. It was possible to map out roughly the territories where these two species were each nesting in colonies of from ten to fifty pairs together. But there was one place on the hill where there were a number of fresh water tarns and some marshy ground. Round this spot there were gathered a colony of great skuas, who never seemed to leave it. I thought at first that they might be birds from the nesting colonies who had gone there to bathe in the fresh water to get rid of parasites, as the kittiwake gulls so frequently do. But closer observation led me to the conclusion (and the watcher on the hill agreed with me) that they were unmated cock birds, which, unable to breed this season, had drawn in from the surrounding nesting grounds on to this apparently neutral territory. (See photograph.) It is well known that skuas are extraordinarily jealous of intruders on their nesting grounds, but I never noticed all the time I was there any of the birds from this neutral ground resent the presence of any bird or animal, whether sheep or human. The evidence seems to point here also to a surplus male population among the skuas.

On another island in the Shetlands this summer I also had occasion to watch for a short time some red-necked phalarope. They were in a marsh near the seashore, and to my surprise I found that the colony consisted of two cocks and one hen. On closer watching I saw that the hen went with one of the cocks and that the other more frequently held aloof from the pair. Here then were a cock and a hen phalarope which had paired, for I found the nest already constructed on the edge of the marsh, although the eggs had not yet been laid. But in spite of the pairing a surplus cock had remained there and was keeping to himself in a little bit of neutral territory at one end of the marsh. This on a small scale bears out the evidence of the skuas.

This whole question of the balance of the sexes of the bird population requires more investigation. If it exists, and it seems to me that it does, is it permanent, or does it vary with the seasons and depend on the rate of mortality of the hen population, and does this in turn depend on the rigour or absence of rigour of the winter? I do not pretend to know, but I can only express a hope that all who can possibly collect material on this subject should do so and record it. The ornithology of Victorian times used to be concerned with a rather stilted classification of birds into their families and genera, the colour of their plumage, their anatomy and the size and marking of the eggs. No doubt this in its day was work that had to be done. But to-day the unknown field of study lies in bird ecology, the relation between birds and vegetation associations, problems of population, sex and generally in the economy and society of bird life.

Yours, etc.,

The Grove, M. PHILIPS PRICE.
Taynton, nr. Gloucester.

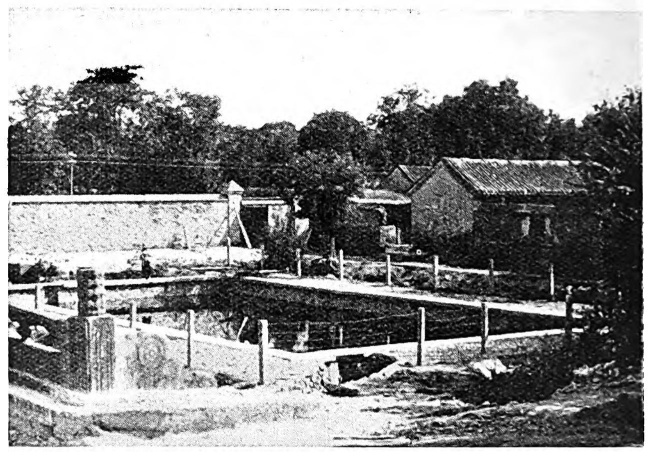
(Mr. E. M. Nicholson is at present out of England, but on his return our contributor's problem will be brought to his notice. It is hoped to deal fully with this interesting subject in a later issue.—ED., *Discovery*.)

THE CHINESE PUZZLE.
To the Editor of DISCOVERY.

SIR,

I am very interested in your recent references to Yenching University, Peking, as I am not long home after having spent three years as accountant in the Construction Bureau, which has built the new plant including the wall you referred to. I enclose a photograph showing a section of the wall: in the foreground is the open-air swimming pool; left, a pillar of a Chinese bridge ballustrade; right, a Chinese house typical of the district. The door in the wall is usually kept heavily sand-bagged.

Your comment July, page 204, that "China is turning to a



national consciousness" contains, in my opinion, the real clue to most of what is happening in China—over and above the endemic civil war—just now. I am sure the tremendous power of ancient family loyalty and its complement, loyalty to personal leaders as distinct from party or cause, is scarcely known and certainly not realized outside Asia. Public and national loyalty is at once both a disintegrating ferment and the seed of the new spirit from which only the future unity of China can come. I place much more faith in the growth of this idea than in "anti"-ism, whether anti-British or anti-Japan, waves of which do not last very long and always contain a lot of artificial, superficial effects, resulting from the terroristic methods of the paid agitators.

Yours faithfully,

Colchester. H. W. F.

AN APPRECIATION FROM PERU.
To the Editor of DISCOVERY.

SIR,

I have to thank you for your kindness in sending me two copies of the April number of *Discovery* and to express my high appreciation of the excellent review you have been good enough to give to Professor Barker's report on our work in this Andean Sierra.

If you can spare me a further two copies I shall be glad to have them, as I am desirous of sending one to His Excellency the President of the Republic.

Again, thanking you,
I am, yours faithfully,
ROBERT J. STORDY, Colonel.

Chuquibambilla, Peru.

Summer and Autumn Travel Notes.

Below are given particulars of various travel services available this summer. The remarkable development of locomotion in recent years has left little new ground for the pioneer, but even to-day few people appreciate how far they may travel during quite a short holiday.

THE progress made since the War in travel arrangements has been so rapid that most people take for granted the galaxy of rival opportunities which summer now has to offer. The recent developments in this sphere are perhaps only paralleled by those of wireless: in the ease with which messages from stations all over Europe and even from America may be obtained, it is natural to forget the early efforts of so recently as 1922, before any official broadcasting had been instituted. In the same way, the spectacular speeds of the aeroplane to-day tend to dwarf the older methods of travel, in which, however, improvements are steadily taking place. The following example was more striking before the War, but it still serves to illustrate the change that is becoming more marked as every year passes. The Emperor Caligula journeyed from Rome to London in twelve days, and eighteen centuries later, in 1840, Sir Robert Peel took exactly the same time to cover the distance. It is not inappropriate to recall this comparison, in 1928, when Rome may be reached by air in twelve hours.

On another page this month a contributor describes a voyage of 4,000 miles to the North Cape in Norway, which can be made in a two weeks' return journey by the B. and N. Line from Newcastle. These steamers maintain the mail service up the Norwegian coast, and run three times weekly throughout the year, although tourist traffic is not recommended after the end of August. More luxurious cruises are offered by the Royal Mail Line, and this month the *Arcadian* makes a final trip to Norway, Spitsbergen, and the Baltic, leaving Leith on 12th August. Two days earlier the *Araguaya* leaves London for ten days in the Norwegian fjords. An attraction for visitors to Sweden is the International Esperanto Congress which opens at Gothenburg on 11th August.

Switzerland.

Switzerland is so closely associated with winter sport that few people are yet aware of its opportunities for a summer vacation. Those fond of climbing and walking have long explored the inland heights, but recently steps have been taken to develop Lausanne as a summer resort. There is now in full activity at the Lausanne-Ouchy Plage, on Lake Leman, a bathing and sporting centre where such new pastimes as water-sledging are provided. This resort on the Swiss "Riviera" is within fifteen hours of London, and the waters of the lake are thrown into picturesque contrast by the snow-capped peaks of the surrounding mountains.

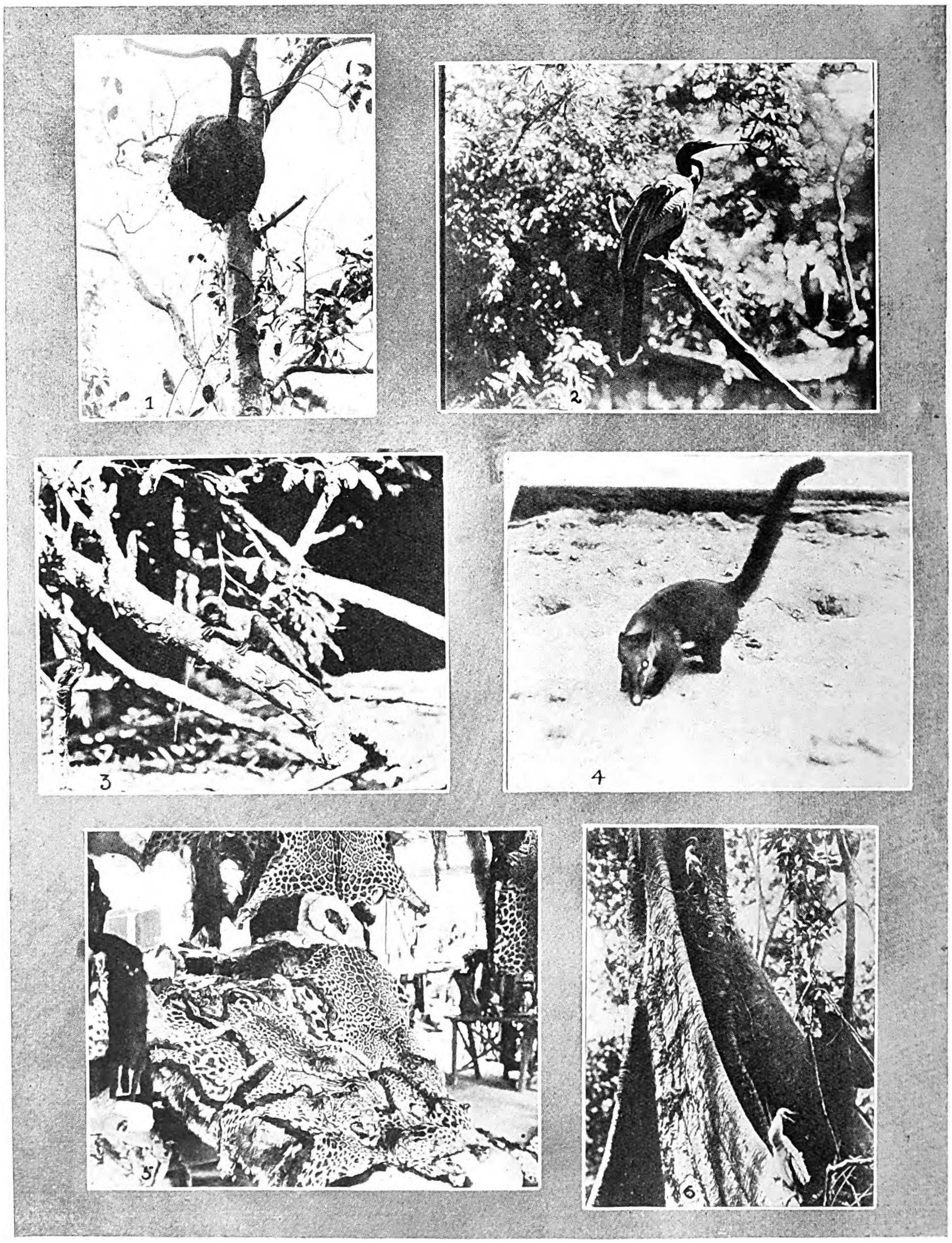
The Near East.

Since the discovery of the Tomb of Tutankhamen, a visit to Egypt has made a strong popular appeal, while those with archaeological interests are provided every year with an increasing harvest of treasures. It is therefore not surprising that a book devoted entirely to Egypt, the Nile, and Palestine has been prepared by Messrs. Thomas Cook, who also run a service of Nile steamers. The routes to the Near East are of wide choice. In addition to the Bibby Line steamers to Egypt, certain Mediterranean cruises embrace the North African ports, and there are holiday facilities on the Peninsula and Orient Line, which offers special terms to Port Said, for Cairo, and the Syrian coast. The same line operates the "Southern Motorway," a new combined steamer and motor service between London and Marseilles.

Constantinople and the Bosphorus are now brought within the scope of a short vacation by the Royal Mail Mediterranean cruise, in the *Arcadian*, which leaves Southampton on 5th October. Railway travel in south-eastern Europe is thus avoided, a factor of advantage to the less experienced traveller. A glimpse of Greece is afforded on this same cruise, which calls in at Phaleron Bay for Athens, before proceeding to Malta and Tangiers.

Those who have time for a longer cruise may explore the West Indies under favourable conditions, as the Royal Netherlands Steamship Company is offering a reduced return fare, including ten days stay in Trinidad. The *Cottica* departs from Dover on the 18th August, and the return voyage is made in the *Venezuela*, which reaches England again on 2nd October. At other periods the Harrison Line run excellent boats on this South Atlantic route.

Of similar duration is the six weeks' cruise to South America and the Amazon by the Booth Line, sailing



NATURAL HISTORY OF THE AMAZON VALLEY

These photographs refer to the accompanying travel notes and show: (1) Tree ant's nest at the Taruma Falls. (2) A brilliant bird of the Cormorant family. (3) Barrigudo monkey (*Lagothrix Humboldtii*). (4) Racoon taken at Pará. (5) Furrier's display at Manáos, illustrating a variety of skins. (6) Egrets on a buttressed tree in an Amazon forest.

from Liverpool in the *Hildebrand* on 14th September. The cruise is unique in that it combines a long sea passage with two thousand miles of romantic inland waters. In spite of the abundant display of tropical flora and forest growth, the climate of the Amazon is scarcely hotter in summer than during the warm winter months. Bathing is enjoyed throughout the year at Pará, on the lower reaches of the river, which before the development of the Florida coast was a pleasure resort of the more wealthy Americans. For the naturalist the Amazon offers a great variety of species. The vegetation includes unusual orchids and the giant Victoria Regia water lilies, while there are many curious animals, besides the birds and insects of brilliant colour. Some of these are shown in the accompanying photographs. To provide for passengers who hesitate to bathe in the river waters, the *Hildebrand* is fitted with a deck swimming pool, which is also of service on the sea journey. An incidental but attractive feature of this cruise is the visit to the Portuguese Riviera, and afterwards to Madeira, the "Island of Flowers" in the calm waters of the southern Atlantic.

The cruise of longest duration beginning in the autumn is that of the Canadian Pacific liner *Empress of Australia*, which for 164 days, from 14th November to 26th April, 1929, will travel round the world covering some 36,000 miles. During nearly the whole period, summer weather will be experienced, for visits will be paid to places of interest in sunny climes such as Egypt, India, China, Japan, Honolulu, the Philippines and Singapore. Christmas Day will be spent in the Holy Land and New Year's Eve in Cairo. Many places off the beaten track will be touched, and a passage will be made through the Panama Canal, on the way to the West Indies, before proceeding to the United States.

These notes necessarily deal with only a few of the many travel services available, but they would be incomplete without a reference to the publications now issued by the British Dominions. The High Commissioners in London, in particular of Canada and South Africa, are offering books which deal with many aspects and are fully illustrated. One of these, for example, is devoted to trout fishing in South Africa, and another to motoring. Indeed, the travel companies equally are realizing the value of well-produced literature, and their brochures to-day, many of them illustrated in colour, are in marked contrast with the badly printed "time-tables" which have been characteristic hitherto. No one who contemplates a holiday should make final plans without first studying these sumptuous publications.

Among the Stars.

By A. C. D. Crommelin, D.Sc. F.R.A.S.

The International Union Meeting.

This great gathering of astronomers at Leiden last month passed off very pleasantly; perhaps the chief value of these meetings is the opportunity afforded for private discussion of plans and ideas. The following may be mentioned among the resolutions adopted. Funds were voted which it is hoped may lead to the completion within a few years of the great photographic star-map and catalogue begun in 1887. A rectification of the constellation boundaries was decided upon; these are in many cases confused and irregular, and are laid down differently by different atlas makers; the lines will be made as straight as possible. There was a decided majority against the use of the phrase "Greenwich mean time" to denote time reckoned from midnight, as this was liable to lead to confusion; all who publish astronomical observations are therefore asked to make quite clear what time they are using. It was also decided to use the equinox of 1950 as far as possible in computations, to avoid the inconvenience of frequent change of date. Where galactic coordinates are employed, the starting point is to be the star Alpha Cygni, not the intersection of the galaxy with the equator, since this is not a fixed point. Arrangements were made that telegrams announcing the discovery of comets should give some notes of their physical appearance which will be of use to observers and computers. It was decided to retain the parsec (*i.e.* the distance at which a star has an annual parallax of one second—it is about 3¼ light-years) as the unit for measuring stellar distances; the distance used for determining absolute magnitudes is to be ten parsecs, as already used by most astronomers. The next meeting of the International Union is to be held early in September, 1932, in the United States, a few days after the total solar eclipse which will be visible there on 31st August, 1932. American astronomers have played a conspicuous part in the remarkable advances that have been made in the last few decades, which makes the choice of meeting-place appropriate, and it is hoped that the double event will attract many European astronomers.

The Solar System.

I have received a new work entitled, "A Theory of the Solar System" (P. J. Harwood) with a request for some notice in these columns. I take the opportunity to offer a few general remarks on works of this character. First, attention should be called to the extreme accuracy with which predictions of the positions of the sun, moon and planets can be made, when we use the tables of their motion which have been constructed on the assumption that Newton's theory of universal gravitation is true. Predictions made many years in advance are verified within a very few seconds of arc (a second is the angle subtended by a thumb-nail two miles away). This verification of prediction is a proof that the Newtonian law is an exceedingly close approximation to the true law, and that any modification required by it should give very nearly the same results as the original law, but with a diminution of the small residuals between theory and observation.

An example is Einstein's slight modification of Newton's law, which explains the fact that the perihelion of Mercury's orbit moves faster by 43 seconds per century than the amount deduced from Newton's law. Mr. Harwood, however, has not

proceeded in this manner; he gives no numerical comparison of theory with observation, but talks in a general way about electrical and magnetical forces, and the behaviour of iron filings in a magnetic field. There is no occasion to deny the presence of electrical and magnetic forces in the solar system; in fact, the former are invoked by many astronomers to explain the violent repulsive action observable in the tails of comets; but they are inappreciable compared with the gravitational forces, except in the case of very finely divided matter. The particles forming the heads of comets are doubtless small, but not small enough for these forces to be appreciable, and the heads of comets are observed to move in agreement with the gravitational theory. A more serious fault in Mr. Harwood's work is the assertion that electrical and magnetic action produce not only radial forces, but also transverse ones. The absence of the latter is demonstrated by the closeness with which Kepler's law of equal areas is fulfilled.

Newton showed in an elementary manner that where a body is describing areas at a uniform rate about a point, it is either acted on by no forces, or the forces are wholly to or from that point.

As an example of its author's vagueness I quote a sentence from page 71 of this book. "It is no doubt futile to attempt to gauge how much attractive movement is contained in the 50 seconds per year of obliquity decrease at present reigning." The actual decrease is 47 seconds per century, not 50 per year, and it is fully explained on the Newtonian theory by the slow change in the position of the earth's orbit plane, due to the attraction of the other planets. The planes of the orbits of all the planets are undergoing similar changes.

Book Reviews.

THE CARNEGIE TRUST REPORT ON PUBLIC MUSEUMS.

A Report on the Public Museums of the British Isles (*other than the National Museums*), by SIR HENRY MIERS, F.R.S., D.Sc., to the Carnegie United Kingdom Trustees. (Edinburgh: T. & A. Constable. 1928).

A Report on American Museum Work. By E. E. LOWE, Ph.D., B.Sc. Published by the Carnegie United Kingdom Trustees. (Edinburgh: T. & A. Constable. 1928).

Reviewed by Sir Frederic Kenyon.

Sir Henry Miers' report on Public Museums, published by the Carnegie United Kingdom Trustees (and obtainable on application to their secretary), will, we hope, mark a definite epoch in the history of British museums, and render them a service comparable to that of the analogous report of Professor W. G. Adams in respect of the Public Libraries. It is a stock-taking of the present position of the provincial museums, based upon personal inspection of the greater part of them by Sir Henry and his assistant, Mr. S. F. Markham, embodying statistics, criticisms, and suggestions which come with unquestionable weight from an authority so well qualified by experience and soundness of judgment.

Sir Henry Miers' verdict on the present condition of the museums of the country as a whole is summary and uncompromising. "At present, in spite of certain noteworthy exceptions, they fail—and fail lamentably. There is no doubt that the country is not getting what it should from the public museums, and that most of them are not going the right way to supply what is wanted." Here are a few of his criticisms in detail: "The distribution of museums in the British Isles is of the most haphazard nature"; "In only a dozen or so is there a full-time competent curator with an adequate staff"; "Rarely, except where a collection has been made with judgment by an archaeological or natural history society, has a beginning been made on sound lines"; "Only ten per cent of the museums in the country are housed in a separate building (good or bad) designed for the purpose"; "Very few are provided with the storage rooms or work rooms which are essential"; "There are comparatively few museums in which the labelling and arrangement can be regarded as satisfactory from the point of view of the average visitor"; "Apart from some of the museums in the larger towns, there is scarcely a general museum in the country that is really well arranged, well housed, provided with the necessary storage and work rooms, and adequately staffed." Finally, "to put it bluntly, most people in this country do not really care for museums or believe in them; they have not hitherto played a sufficiently important part in the life of the community to make ordinary folk realize what they can do. The very word 'museum' excites quite the wrong impression in the minds of people who have never seen one of the few that are really good. This is not surprising when one considers how dull many of them have become and how low the worst of them have sunk."

This is a sufficiently serious indictment, and points to a clear-cut alternative. Either museums, as public institutions spending public money, should be abolished, or the country should put its house in order with respect to them. The former alternative is, it may be hoped, unthinkable. Whatever may have been the case formerly, during the last generation the interest of the public in antiquities, and perhaps (though less certainly) in natural history, has been increasing rapidly. The Press has done much to foster this interest. The educational value of museums is increasingly recognized. The national museums and the great provincial museums are visited by ever-increasing numbers, for purposes both of recreation and of instruction; and here and there small local museums, planned with a definite purpose and guided by competent and enthusiastic curators, are doing services of real value to the community. At a time when every influence which combats the forces of ugliness and materialism should be cherished in order that the soul of the community may be kept alive, it would be criminal to neglect institutions which have such potentialities for good as our museums.

The Carnegie report comes, in fact, at an opportune moment. The local museums of this country have for the most part grown up fortuitously out of collections made by travellers or individual enthusiasts, and have been left to exist as they could, with inadequate means and haphazard staffing. The country is just beginning to be aware of their potentialities, and here and there localities have tried to develop them; but the movement is only beginning to gather strength. The report, it may be hoped, will strengthen the hands of those who are trying to educate public opinion. It indicates some of the defects; it suggests improvements that may be tried. It should arouse a sense of shame in backward communities. It should encourage local authorities to be more generous in

providing for the institutions for which they are responsible. It may give hope to starved and neglected curators.

Some of the remedies suggested by Sir Henry Miers may be briefly mentioned. Museums should have a definite scope and purpose. They need larger staffs, better paid and better educated. They should co-operate with one another by exchanges and mutual loans, thus getting rid of objects which do not fall within the accepted scope of each museum, and promoting that variety of exhibitions which is the chief means of keeping public interest alive. Certain special museums are needed, notably for agriculture, nautical history, and local life and customs. Travelling collections should be organized, perhaps upon a county basis, especially for use in schools, but also for such subjects of general importance as hygiene or local industries. The national museums might be asked to help with inspection and advice, and perhaps to constitute a permanent advisory board. Lectures, labels, guide-books, and visits by schools and adult classes should be organized. Municipalities and counties should recognize their responsibility for turning the museums within their jurisdiction into active agencies for public service.

Useful hints with regard to some of these activities, especially on the educational side, may be derived from America; and here Dr. Lowe's report is a valuable supplement to that of Sir Henry Miers. It does not profess to be an exhaustive survey of that very extensive field; but Dr. Lowe visited many of the most enterprising museums in America, and his experience enabled him to make the most of a limited visit. Conditions in America differ so much from those at home that direct imitation is neither possible nor desirable; but much may be learnt in detail, and in particular we should do well to emulate the whole-hearted belief in education which is so widespread in the best parts of the United States.

If the Carnegie Trustees, armed with these reports, can see their way to apply to the museums of this country the same wise stimulus and guidance which has done so much for the libraries, they will render yet another service to the spiritual well-being of our nation.

Slavery in the Roman Empire. By R. H. Barrow. (Methuen. 15s.).

Here we have an admirable account of the most remarkable and characteristic institution of antiquity at its time of greatest development. Mr. Barrow reviews the conditions of slaves during the first two centuries of the Empire—in the household, on the land, in trade and industry, and in the service of State and town. He is familiar with the literature bearing on the private life of this period, and has ransacked the ten thousand inscriptions of Dessau to good purpose. We might perhaps wish that he had made more use of the earlier literature; Latin comedy gives us interesting sidelights on many of the topics which he discusses, and Imperial conditions cannot be fully understood apart from their Republican origins. Still, limitation of some kind is here undoubtedly necessary.

Slavery is so ill-sounding a word that any dispassionate examination of its actual workings tends to become in some measure a defence. No one seriously blames the Romans for adopting what was indeed a universal institution. As to the use which they made of it, that is a complicated matter, the study of which gives us glimpses into some of the most unlovely features of the Roman character. It is, however, gratifying to discern a general tendency towards amelioration of the slave's lot—even if this process arose out of nothing higher than enlightened self-interest. Slavery became more than a mere institution which treated men as tools; it grew into a vast educational system which fitted untold multitudes of backward folk for the burdens and honours of citizenship. Particularly interesting in this connexion is the account of the *collegia*. Through them and through pride in his work, some barbarian might, and often did, acquire social standing and culture.

Mr. Barrow is cautious in his treatment, but in many places he disagrees with conventional theories. This is particularly the case with regard to the *latifundia* and the supposed destructive effect of slavery and the importation of corn on the peasant life of Italy. Here in general he is in accord with Rostovtzeff. Of special value in his description of the *peculium*, though here we are left in doubt as to the extent of the master's rights, or rather as to the extent of what is known about the master's rights. The reference to Pliny I, 4 on page 49 seems to take too seriously what is surely a semi-humorous passage.

The reader will probably be most interested in the comparison between ancient and modern slavery (to the advantage of the former) and in the speculation as to how far slavery was responsible for the fall of the Empire. As to this last problem, we are left without any definite answer. Slavery, and the mingling of peoples which it assisted, were part of the very fabric of Rome. They contributed both to her greatness and to her decline. But the real causes of that greatness and that decline are to be found elsewhere, if at all.

W. Beare.

A Textbook of General Botany for Colleges and Universities. By R. M. Holman, Associate Professor of Botany in the College of Letters and Science of the University of California; and W. W. Robbins, Associate Professor of Botany in the College of Agriculture of the University of California. Second Edition. Chapman & Hall. 20s.).

Reviewed by Professor A. C. Seward.

Most teachers of botany have probably been tempted, at some stage of their career, to write a book which might be used by their students as a source of knowledge and set the lecturer free to spend more time on general principles and in providing the wisdom which lingers far behind knowledge. Fortunately, or in some few instances unfortunately, some teachers have resisted the temptation; many have fallen. The authors of the book under consideration, in the preface to the first edition, express the opinion, shared by a large body of their colleagues on both sides of the Atlantic, that a textbook which presents the "whole content of the usual lectures and the fundamentals of general botany would result in better teaching, since it would make it possible for the instructor to devote more of his time and energy to the more effective work of recitation, conference and quiz." It is not clear what is meant by recitation—one hesitates to suggest the possibility of a class reciting in unison even the most moving utterances of a lecturer—but "conference and quiz" are, no doubt, what we should call a catechetical class at which questions and discussions are encouraged, a method beneficial to teachers and students alike and insufficiently used in this country. The practice of formal lectures is too firmly established to be easily abandoned; most of us are conscious of the fact that a much better way might be found. The trouble is that the majority of elementary students regard lectures as substitutes for books, and the easiest course is to be accommodating and treat students as buckets to be filled. The question is how far have the authors succeeded in providing an adequate and stimulating book?

A partnership between a Professor of Botany in a College of Letters and Science and a Professor in an Agricultural College was a happy idea; the authors hold the sound view that agricultural students will "profit more by a broad survey of the whole field of botany . . . than from a special course . . . restricted to those aspects of botany which are capable of the most obvious and direct applications to agriculture." It is in the highest degree desirable persistently to emphasize the importance of laying foundations in the only true way, by insisting on pure science as the basis of applied science. An interesting feature of the new edition is the inclusion of brief statements of certain principles for the benefit of readers who have had no adequate training in chemistry and physics; to some students these excursions into physical science will be helpful, though in a general botanical textbook it is impossible in a few pages to supply a satisfactory substitute for preliminary courses in chemistry and physics. The authors have made plain many physiological descriptions which are often presented in terms unintelligible to readers imperfectly equipped with a knowledge of chemistry.

The first part is devoted to the structure and physiology of seed-bearing plants, and occupies more than half the volume; the second part consists mainly of a survey of the plant kingdom. This arrangement has presumably been found by the authors the most convenient method of approach, but whether it is the best method educationally is open to question. There is much to be said in favour of beginning with a general description of some familiar flowering plant; having used as an illustration of a highly specialized type some common plant, in which the principle of division of labour is most clearly expressed, the lecturer can then proceed to a general survey of the plant kingdom, beginning with unicellular green plants and working up through colonial, filamentous, and more elaborate forms to the higher vascular plants. The advantages of this method are that the student becomes interested at the outset in the idea of evolution, and he is better able to appreciate and to follow a general comparative treatment of biological types and plant forms after, rather than before, he has been introduced to representatives of the various groups.

The book may be described as a good introduction to botany; it is clearly written, and pains have been taken to minimize the difficulties inherent in the order of presentation which has been adopted. The average student should have no difficulty in obtaining a true picture of the cell, plant-tissues and plant organs, and of the principles of physiology; the chapters are not overloaded with detail and the illustrations are generally satisfactory. The term dictyostele is applied to stems of Dicotyledons in which the vascular bundles are separated from one another by pith-rays; surely this is not the usual definition of a dictyostele as illustrated by the stems of many ferns. The account of the corm might with advantage be fuller and more clearly related to the life of the plant. In the figure of an anther (Fig. 175) the fibrous layer and other important details are omitted. It is all very well to avoid detail that is merely tiresome and unnecessary, but when anatomical features are obviously capable of correlation with function it is important that they should be fully described. There is a tendency, no doubt caused by a striving after simplicity, to adopt one interpretation without any reference to other equally possible interpretations. The cone-scale of a pine affords a good example; the morphological description given by the authors may be correct, but it would certainly not be accepted by all botanists. In certain instances it is not only fair to give more than one view, but it is very important to lose no opportunity of encouraging students to think for themselves. Our object is to encourage students to teach themselves, and if we can awaken their critical faculties by offering alternative interpretations of morphological features, and leaving them to form an independent opinion, so much the better.

In Part II many of the selected types are clearly described and on the whole adequately illustrated. It is unfortunate that no account is given of the life-history of *Laminaria* or of some other brown alga in which an alternation of generations has been proved to occur. As in many textbooks the Gymnosperms do not receive as full a treatment as they deserve. A serious defect is the neglect of extinct types, which should at least be mentioned and the more interesting briefly described even in an elementary textbook. There is much that is admirable in this American textbook, and such criticisms that are offered are made in a friendly and appreciative spirit.

Engines. By PROFESSOR E. N. DA C. ANDRADE. (G. Bell & Sons. 7s. 6d.).

Not the least striking achievement in the brilliant career of Sir William Bragg is the remarkably high standard which he has set for the annual Children's Christmas Lectures at the Royal Institution of Great Britain. These lectures have become one of the outstanding scientific events of the year, and the man of science who is honoured by the invitation to deliver them is faced by no easy task. Last Christmas the choice was a happy one, for Professor Andrade has a wide reputation as a man, not only possessed of profound scientific knowledge, but one who is gifted to an almost unique degree with the power of imparting it in a lucid and entertaining manner.

Professor Andrade is a physicist (among other things), and it is a somewhat novel thing for such a one to choose "engines" as his subject. It is a fascinating theme, and its choice argues a shrewd understanding of juvenile psychology. The title of the lectures alone was quite enough to ensure a crowded lecture theatre and to sell thousands of copies of this book.

"Engines" is so full of good things that it is difficult to know which to mention first. The first chapter, dealing with the rules all engines must obey, is a skilful lesson in elementary mechanics and thermo-dynamics, made very palatable indeed by numerous ingenious and fascinating experiments. The tense and happy expressions on the faces of the audience after the first lecture (the frontispiece), will cause a pang of envy to stir the soul of many a school science-master. The graphic descriptions of early engines, and the principles upon which they work, form an interesting prelude to the detailed explanations of all the important modern engines which have developed almost out of all similarity to their crude forebears.

The next section of the book is concerned with reciprocating engines, and in this chapter, of course, is comprehended all the details of modern locomotives. Notwithstanding the fascination which locomotives always possess, many readers will think that the two most interesting chapters in the book are those which follow, and which describe turbines and internal combustion engines respectively.

The chapter on turbines is an education in itself. The relationship of the toy turbine of the early seventeenth century drawn by Branca, and the gigantic 50,000 kilowatt Parson's Reaction Turbine at the Crawford Avenue Power Station at Chicago, may seem at first sight to be non-existent. The author, however, draws the *character* of the turbine with a sure hand, and we are made conscious of its persistence through

all its modifications in the most vivid manner. It is opportune at this particular chapter to refer to the splendid plates which adorn this book. There are thirty-five of them altogether. Those illustrating the turbine chapter are superb. One of the most striking is a gigantic low-pressure turbine rotor (with blades) weighing no less than fifty-four tons. Another shows a marine geared turbine with all the covers removed, and displaying the parts that have been so well described in the text.

Internal combustion engines have a strong claim on the imagination, for they are familiar to everybody as motor-car engines, and they also provide the motive power for those awe-inspiring denizens of the deep called submarines. No boy can fail to be thrilled by a description of a large Diesel engine.

Professor Andrade calls this chapter "Putting the furnace in the cylinder," and in it he tells us all about motor-car engines, aeroplane engines, and big Diesels.

The last chapter deals with the way in which refrigerating machinery is operated, and the author hints at developments whereby heat may be collected in the garden and persuaded to come indoors and warm the house.

This book should be in the hands of every boy in the country, as it will be in those of a large number of grown-up boys. It is one of the best seven-and-sixpenny-worths that we have seen for some time. It is particularly well produced and the plates, as we have said, are excellent. There are also numerous explanatory diagrams which are well drawn and are always to be found when demanded by the text.

It would be an omission indeed not to mention the dedicatory verses to Sir William Bragg. The dedication illustrates the author's remarkable versatility, and is a most graceful and apt compliment to the great physicist to whom it is addressed.

V. E. PULLIN.

Wildfowl and Waders. By MAJOR HUGH POLLARD. Illustrated by the late FRANK SOUTHGATE. (Country Life. £3 3*s*.).

No one should know more about the ways of wild duck and such winged game than the man who goes out to shoot or snare them. But the sportsman, unfortunately, is not always a scientific observer; and even when he knows more about his particular sort of game than its nesting places, its speed on the wing and the size of shot to take to it, he has not, as a rule, any grace with the pen when he tries to put his knowledge into writing—or print.

But Major Hugh Pollard, the author of this sumptuous book, beautifully illustrated by the late Frank Southgate, is at once sportsman and naturalist and good writer, which is the reason why his book will appeal as much to the man who goes hunting with no more deadly weapons than camera and spyglass, as to the gunner who is willing to crouch in his hide all day on a Norfolk marsh for the chance of a shot at wild goose or sheld-duck.

And some of the birds which may make up the sportsman's bag at the end of a lucky day on such a marsh provide very interesting problems for the ornithologist. There is that fascinating problem of migration; what it is that brings the flocks of wild duck to these shores at the same time every year from their breeding grounds in Siberia or even farther north. Many theories have been advanced by ornithologists; but we still do not know whether it is the mere blind working of instinct that brings the wild duck south to our coasts in the last fortnight in October—if they come at all—or whether the flight has a practical reason in shortage of food or bad weather on the breeding grounds.

Major Pollard himself contributes a new theory to the discussion of this point. He suggests that the shortening of the days and the lengthening of night in the northern latitudes may be the cause of the wild ducks' southward flight; a flight in which wind may be a considerable factor, not only to the birds but also to the sportsman waiting news of their arrival.

Sometime the duck do not come at all. What puts them off? No one knows. All that is known is that if the great main invasion of migrant duck—perhaps preceded by small scattered parties—does not come within the twenty-second of October and the first of November, "you may wait in vain for their arrival that year; some will come, but generally speaking average numbers will be down two-thirds, and it will be a bad duck year."

Another fascinating problem is why wild geese fly always in that triangular formation called a "gaggle"; and whether perhaps one gaggle has the onerous duty of leading the rest during the migrating season. Anyway, even when a large flock is flying together, the individual "V's" which compose it keep station with the accuracy of a squadron of battleships. Perhaps this is due to the fact that the leader of the "V" is nearly always the oldest and largest and no doubt wisest bird. The younger birds fly at the side.

"Geese appear to rely for protection against their enemies entirely on their eyesight, rather than sense of hearing or sense of smell. It would seem that each individual gaggle leaves this duty to the flight leader. Shoot the leader and all is confusion; shoot a side bird and the discipline of the group is not half so affected."

But wild geese and wild duck are only two of the many varieties of wildfowl and waders with whose ways the author of this book is very familiar. Dunlin and snipe and godwit, whimbrel and curlew and teal, he knows them all, with the intimate knowledge of the naturalist as well as that of the sportsman: how they nest, what they eat and what they are like to eat. His book is therefore one to interest even those who, in the words of the old proverb—which has become rather corrupted—do not know a hawk from a hernshaw.

K. K.

A Short History of Medicine. By CHARLES SINGER, M.A., M.D., D.Litt. (Oxford University Press. 7*s*. 6*d*.).

This is no mere history of the advances in medical knowledge and surgical technique from the earliest times, still less is it a compilation of biographies. It is a pleasantly written record of the tendencies towards definiteness in thought which in the course of ages have made the healing art a science. There is a refreshing perspective attained in this work, for Dr. Singer does not, like many other historians of medicine, devote a large amount of attention to the views and speculations of the ancients, and then find that he has almost no space in which to deal with the very important advances of the last one hundred and fifty years. The whole of the history of Greek and Roman medicine, including the work of Galen, occupies only the first eighty-one pages out of a total of three hundred and fifty-one, so that the ancient days are not allowed to attract too much attention.

The important contributions to physiology by Bell, Magmore, Marshall Hall, Müller, Claude Bernard, Ludwig, Helmholtz, Schwann, Köllike and Virchow are described in sufficient detail to enable us to relate them to the advances made in our own time. It is the continuity of achievement that impresses us in Dr. Singer's narrative; a discovery is not merely described

and left in a chronological pigeon-hole, it is at once related to the state of matters at the present day. The book teaches us some modern medical science as well as ancient history.

The sections dealing with the rise of bacteriology and its subsequent specializations, the study of immunity, and some practical applications as to the "conquest of the tropics" and what has already been done to banish malaria and yellow fever, are as interesting as any in this book. To understand this part of Dr. Singer's exposition is to receive a liberal education. Much of the childish anti-medical and anti-scientific point of view—the view of the "cranks" of to-day—is as much the outcome of sheer ignorance as of mental inertia and ineducability. The "conscientious objector's" act in regard to vaccination could never have become law if its promoters had been informed in early life of what preventive medicine means, has accomplished, and may yet achieve.

The book closes with a discussion of such topics as the revolution in nursing, the modern conceptions of internal secretion, vitamins and nervous integration.

There does not seem to be any reference to the work of Berzelius who did so much for chemistry and introduced the notion of "catalysis" into scientific thought. The names of those in the modern period who built up the "Newton doctine"—Waldeyet, Golgi, and Cajal—we look for in vain. And indeed, neither Fleurens nor Gall are mentioned in the narrative of discoveries in the nervous system.

Something must be said about the illustrations. They are numerous, they all show what they are intended to, some of them are made available here for the first time, and many of them are from out-of-the-way sources.

D. FRASER-HARRIS.

How Animals find their Way About. By ETIENNE RABAUD. Translated by I. H. MYERS. (Kegan Paul. 15*s*.).

This new volume in the International Library of Psychology, Philosophy, and Scientific Method, is by an author who is a well-known entomologist and whose work has been largely upon wild bees and wasps.

After Chapter I, which details the problem and the method of the author, there are two chapters upon insects, one dealing with the orientation of flying forms and the other with that of walkers. These occupy about ninety pages and are very good, the argument being worked out with great care. Chapter IV deals with the orientation of other invertebrates, and begins with a short paragraph on the termites, which seems to have got out of place. The information in this chapter is most meagre, being almost confined to the movements of the limpet.

The next chapter, on the vertebrates, is also poor by comparison with the earlier ones, as the author has by no means exhausted the available material nor, to my mind, has he exhausted the arguments in favour of his own view, which is that animals possess no special sense of direction, but that they find their way about by using the ordinary senses, chiefly sight and touch.

It is interesting to note that, whereas the author regards flying insects as relying largely upon the recognition of objects along the path of flight and walking ones as relying largely upon the position of the sun, Dr. Ernst Wolf has recently stated that bees rely largely upon the latter.

Although our author's arguments, based upon experiment, appear to be convincing, the question is evidently not finally settled.

FRANK BALFOUR BROWNE.

In an Unknown Land. By THOMAS GANN, M.R.C.S., L.R.C.P. (Duckworth. Cheap edition. 10*s* 6*d*.).

Mystery Cities. (1925).

Ancient Cities and Modern Tribes. (1926).

Maya Cities. (1927). By the same author. (Duckworth. 21*s*. each volume).

For some years past Dr. Gann, the well-known archaeologist and traveller, has made a practice of publishing annually a volume dealing with his explorations of the previous winter in Central America. This argues a confidence in his public which not every writer might find justified by the event. Dr. Gann has no need to fear the verdict. The areas he covers, Honduras and Yucatan, are in large part unknown, and penetrated only by the chichle hunters who gather the raw material for chewing-gum ; and the object of his search, the lost cities and forgotten culture of the ancient Maya civilization, has that grip on the imagination which for most is the element of attraction in the attempt to reconstruct the history of a vanished past from the material fragments still preserved to us in the passing of time. Add to this that Dr. Gann has a lively and graphic pen, an ability to select from the multitude of impressions in the jungle those which will appeal most vividly to the reader, and an eye for character, eccentric and otherwise, in both Indian and White. For these reasons alone Dr. Gann will not weary his public ; but he is fortunate that, in addition, he has been able to record in each season discoveries which have been valuable additions to our knowledge, and on occasion have bordered on the sensational.

In the earliest of these volumes, "In an Unknown Land," the interest is divided between the archaeological and the ethnographical, for in addition to exploring unknown and unvisited cities of the east coast of Yucatan, he succeeded in penetrating the country, usually barred to Europeans, which is inhabited by the Santa Cruz Indians, who are here described for the first time. In the following year, 1925, he was digging at the then newly-discovered city of Lubaantun, now being explored by the British Museum Expedition, a site on which have been found monuments, both as a whole and in detail, unique in America. It promises to be the most remarkable of all the sites of Central America. It is indeed fortunate that it has been found possible to undertake its systematic exploration. Among the most important discoveries recorded in "Ancient Cities and Modern Tribes" was that remarkable ceremonial causeway of cut stone connecting a previously unknown and vast Maya city, the third largest in Yucatan, to the ancient social and religious centre of Chichen Itza, fifty miles distant. A discovery which gained wider publicity at the time was the discovery of an inscription giving a Maya initial series date A.D. 333, which is nearly three centuries earlier than any of the three other initial series dates known from Yucatan, and proves an earlier penetration of the Maya to this part than was previously suspected.

The last volume under notice, "Maya Cities," does not fall behind the others in interest either in its descriptions of ancient cultures, or in its account of the Indians. Indeed, in regard to the latter, it records ceremonies in which Dr. Gann took part and religious beliefs still to a large extent unaffected by Christianity, which may well go back to the Maya. But most thrilling of all Dr. Gann's adventures was a hunt, unsuccessful it is true, for a treasure temple upon evidence as romantic as any lover of treasure-hunting stories would desire. What this evidence is we leave it to Dr. Gann to tell.

E. N. FALLAIZE.

DISCOVERY

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Editorial Notes.

As we go to press the City of Glasgow is preparing to welcome the British Association, which holds its ninety-sixth annual meeting there from 5th-12th September. The sessions will take place in the spacious accommodation of the University, whose imposing buildings rival the ancient cathedral in reminding visitors of the historic connexions of Glasgow and its surroundings. Although the Clyde is most generally noted for its shipbuilding and engineering activities, which make it one of the foremost industrial centres in Britain, it was the scene of many famous events in Scottish history. Our article on another page dealing with the British Association programme mentions some of the excursions that will provide members with a glimpse of both these aspects of Glasgow. One of the impressions likely to strike those who are visiting the Clyde for the first time is the suddenness with which the industrially populated districts give way to gorgeous yet rugged scenery, an impression which emphasizes the hardy existence experienced along the west coast of Scotland. For several years past *Discovery* has published a British Association Number, not only for the interest of the considerable number of readers who are already members, but to provide a picture for the large majority unable to attend the meeting. Science has always been advanced by discoveries, and in that common bond we may express to the British Association our renewed good wishes for its continued progress.

* * * *

Whatever may be the significance attaching to the boycott in City circles of the shares offered by a totalisator company floated in London last month, we believe the publication of an article on this invention will be welcomed. Major Ralph Glyn, M.P., our contributor, who introduced to Parliament the Racecourse Betting Act which has now received the Royal assent, is careful to avoid dealing with any particular make of machine, and he treats the subject purely from a technical point of view. While fully recognizing that the moral question involved by betting in any form is serious, and one which arouses heated controversy, the fact that *Discovery* is unable to entertain such discussion does not preclude the description of a betting invention in its columns. In explaining the workings of the totalisator certain remarks on existing betting practice are inevitable, for example, that the new machine provides a more equitable distribution of the proceeds; yet the most ardent opponent of gambling will desire a working knowledge of this device, if only that he may combat it more intelligently. We publish these remarks on Major Glyn's article not by way of apology, but to emphasize in advance that the editorial policy of *Discovery* provides only for the scientific discussion of such current problems.

* * * * *

Particularly in America, considerable attention has been attracted by the striking figures which Mr. H. J. Massingham advanced in his recent article on "The Close of the Age of Mammals." From a utilitarian standpoint—apart from what the author called "the sacred heritage of evolution"—the wide destruction that has marked the last fifty years is beginning to reflect itself in a scarcity of certain fur and skins, and some of the once plenteous sources of food are already on the decline. We therefore read with special interest an account of experiments with the buffalo in Canada, which has just been issued by the High Commissioner. Few chapters in the history of wild life conservation contain such a thrilling story. From the proud position of "lord of the plains" when it was numbered in millions, the buffalo was

brought to the verge of extinction. At one time the Indian tribes in western America practically subsisted on its meat, but this considerable destruction never equalled the annual increase of the herds. With the arrival of the white man, however, a disastrous inroad on the species began, and this had reached its limits when the Dominion Government first took steps twenty years ago. A further experiment was begun in 1925, and this year more than a thousand surplus animals have been removed from the National Park at Wainwright to a newer preserve in the North-west Territories known as Wood Buffalo Park. Similar progress is being achieved with the Big Horn sheep, and a Canadian contributor sends us this month a picturesque account, with some photographs taken in the Rocky Mountains.

* * * * *

Dr. Roy Chapman Andrews, the leader of the American expedition in Mongolia, has discovered many unusual specimens during his latest journey. Ninety cases of fossils have been brought back to Peking, including quantities of stone implements, and ornaments such as necklaces made of fox teeth. It is reported that north of Kalgan the expedition discovered remains of dinosaurs which may be as much as eight million years old. Another important find was the huge mammoth head of a titanothere hitherto known only on the American continent. Apparently it is a new variety, as the nasal features are distinct from the known types. Dr. Andrews travelled five thousand miles, and he encountered severe sandstorms throughout the journey

* * * * *

We recommend for support the enterprising work of the International Educational Society, which has been formed for the purpose of exchanging by mechanical means the selected lectures of scholars of all nations. In the first instance gramophone records are being used to this end, and those already available include " Specimen passages from Latin authors—as a guide to correct pronunciation," by Professor R. S. Conway. A similar lecture on " Shakespearean Recital " is recorded by Sir Johnston Forbes-Robertson and Mr. Walter Ripman deals with " Good Speech." Apart from its value in exchanging knowledge between different countries, the gramophone for pronunciation purposes is only rivalled by the wireless. Incidentally, contrary to expectation, the newer means has given a considerable fillip to its predecessor, as we found a few weeks ago on visiting one of the largest British gramophone factories. The International Educational Society (189 Regent Street, W.1) is providing double-sided records at the uniform price of four shillings and sixpence; the President is Mr. H. A. L. Fisher, and it is not in the accepted sense a commercial undertaking.

* * * * *

A new cinematograph invention, claimed to be as important as the introduction of Mr. George Eastman's first Kodak camera in 1888, was privately demonstrated last month in London. " Kodacolour," as it is called, enables motion pictures in natural colours to be taken with an ordinary amateur's machine, all that is necessary being to place a filter on the lens of the camera for use in conjunction with the special film. This filter is a transparent gelatine disc, divided into three sections representing the primary colours—red, green, and blue-violet—and as the light passes through the disc it becomes separated into its appropriate colour group. The film itself introduces a revolutionary element in photographic manufacture. The side opposite the sensitive emulsion is embossed with thousands of minute cylindrical lenses, invisible to the naked eye. The light rays, before impinging upon the emulsion, pass through these lenses, behind each of which three distinct microscopical black and white images are formed, one for each primary colour. A gelatine disc similar to that used on the camera is placed on the lens of the projecting apparatus, which produces a picture in natural colours on the screen. From the first demonstration afforded, we cannot endorse fully the Kodak company's claim that the picture was " perfect," for the greens in particular were inclined to be harsh. But the invention is undoubtedly epoch-making, and as it will not be available to the British public until next year, there is plenty of time for improvement meanwhile.

* * * * *

A new record in deep-sea diving was achieved last month by Italian divers, who are now working off the coast of Brittany in an attempt to salvage the Belgian steamer " Elizabethville." This was sunk by a German submarine in 1917, and contained jewels and precious stones valued at over a million pounds. The apparatus used is made by the firm of Sorima, and the results so far achieved, according to *The Times*, make it possible to say that the major problem of deep-water salvage has been solved. Previously not a rivet from a wreck has ever been brought out by a diver at forty fathoms, but at Belle Ile, on 5th August, two divers in eight hours sent to the surface from that depth about twelve tons of material. All the gear worked perfectly throughout the day, and neither diver showed sign of distress or fatigue. We hope that the same success will accompany the efforts of the other Italian engineers who are working by different methods on the famous barges of Caligula.

Raising the Barges of Caligula.

By Daphne Shelmerdine.

Italian engineers are now in process of draining the Lake of Nemi, in order to raise the famous sunken barges of the Emperor Caligula. The author recently visited the lake and describes the proposed operations.

SOME eighteen miles south-east of Rome lies the Lake of Nemi, which was called by the ancients the Mirror of Diana. This year the lake is being drained of its water by means of electric pumps, in an attempt to discover the two great barges of the Emperor Caligula which lie sunk at the bottom. The history of the lake is a strange one, and this is not the first attempt to discover its hidden treasures.

The First Attempt.

Five hundred years ago Cardinal Prospero Colonna, whose family held the villages of Nemi and Genzano in fief, obtained the help of the engineer Leone Battista Alberti in a similar enterprise. Alberti caused a raft to be made, upon which he erected machinery, and let down into the lake great chains with hooks upon them. Seamen from Genoa were hired to fasten the hooks round the prow of one of the ships. They surprised the peasant inhabitants of the lake villages by their fish-like agility, but their diving was of no avail, for the chains broke, bringing only fragments of timber to the surface. This was between the years 1431 and 1439.

A hundred years later, on 5th July, 1535, the famous military engineer, Francesco de Marchi, made a descent in a diving bell, invented by Guillaume de Lorraine; but the attempt again ended in failure, though de Marchi's account of his expedition was exciting enough. The convex glass of the aperture through which he spied into the bowels of the lake acted as a lens, by which he saw fabulous sights; more strange than Edgar's imagined view from the cliff top, when he saw crows "scarce as gross as beetles" and "fishermen that walked upon the beach appeared like mice." De Marchi's vision was an inverted one. The lens magnified what he saw: tiny fish swimming in the water appeared monstrous beasts, and the great ships themselves he reported to be 475 feet in length.

They were, indeed, of an enormous size, but not so fantastic as this. An accurate description was not forthcoming until last century, when two further attempts were made. The first, that of Annesio Fusconi in 1827, was inaugurated with a great ceremony, to which were invited prelates, diplomats, and noblemen to witness the beginning of operations. But this fine company which gathered about the desolate lake on platforms constructed for the spectacle saw no secret wrested from the silent water. It was not until the end of the century, in 1895, that a more definite account was given of the size and grandeur of the lost barges. By means of floaters attached by strings to the ship, Eliseo Borghi then outlined the form of a great barge upon the surface of the lake, while divers brought up mooring rings of great beauty and huge timbers were dragged above the water.

The first ship is about 200 feet long; the length of the second is probably more than 250 feet. Their depth is unknown, for their long burial has silted them up with sand. Their parapets are gilded, the decks paved with porphyry; bronze heads of lions and wolves, fashioned with exquisite workmanship, hold the mooring rings in their mouths, and fountains once played amidships. On the lead pipes Caligula's name is inscribed.

Unknown Purpose.

For what purpose where these enormous vessels, at least forty feet longer than the men-of-war of their day, launched upon a tiny lake which measures only four miles in circumference? Were they floating palaces, the property of Caligula, sunk by some catastrophe, or were they abandoned as Julius Caesar's large and costly villa on the shores of the lake was abandoned, because it was not to his liking? Or had they some connexion with that other and deeper mystery of Nemi, the sanctuary of Diana?

On the northern shore of the lake is a flat piece of ground called Il Giardino. Here, overgrown with bushes and thick grass, are the remains of a huge wall, some 700 feet long and 30 feet high, which forms two sides of a square on the north and east. In it are cut niches like chapels, filled now with trees and tall grass. The terrace it encloses rested, on the lake side, on a buttressed wall which was once probably lapped by the water. Upon this terrace stood the temple of Diana, thirty metres long and about half as broad. In its north-east corner a circular basement has been discovered which probably supported a vestal temple like the round temple of the Vestal Virgins in Rome. The terrace is now cultivated as a flower garden, and

sends daily to be sold at Rome the flowers for which Nemi is famous. In the spring it is a field of violas, stretching in a purple carpet from wall to wall. Such is the site of the famous sanctuary of Diana Nemorensis, which day and night was guarded by a priest whose successor slew him and was himself slain in his turn.

Conflicting Legends.

The foundation of the sanctuary is told in conflicting legends; its origin is lost beyond the reach of history, springing from remote and powerful beliefs in Diana, "the mistress of mountains and forests green, lonely glades and sounding rivers," of the chase, and of wild beasts and tame animals; the goddess of fertility and teeming life, who made the barren fruitful and conferred her blessing upon pregnant women. In those days the now desolate Campagna was thickly grown with trees, and the woods at Nemi were dark and sombre groves. Wild boars roved the primaeval forest. On the summit of Monte Cavo, then known as Mons Albanus, rose the great temple of Jupiter Latialis. The neighbouring Latin cities looked with reverence towards the deep groves at Nemi, where the King of the Wood waited with drawn sword for his successor, guarding at once the goddess and his life.

The barbarous priesthood lasted into the times of the Antonines, when it was reported by a Greek traveller. While the long succession of Kings of the Wood fought and won, and fought again and died, the shrine of Diana increased in riches and splendour. Images of Egyptian goddesses, of Isis and Bubastis, were set up by Eastern potentates by the side of the statue of Diana the huntress, and of models of stags and hinds and the wild animals of her forests. So rich was the sanctuary that Octavian despoiled it of some of its treasures to fill his coffers. Tiles of gilt bronze roofed the temple, which was built of blocks of peperino with Doric columns. Diana was worshipped with fire and her great altars flamed beside the shore. On the 13th of August her annual festival was kept with sacred rites at every hearth in Italy; at Nemi a multitude of torches lit the dark grove, as the pilgrims processed to her shrine and besought the goddess for the fruitfulness of their lands, the blessing of their vines, the safe delivery of their children. This festival was later to be sanctified by the Christian church as the feast of the Assumption of the Blessed Virgin Mary, on August 15th, and to her also the people, changing their faith but not their desires, prayed for a blessing on the vines.

Perhaps the great barges of Caligula took some part in the Festival of the Ides of August, and while the procession of torches lit the grove, Caligula's ships upon the lake, with their marble decks and playing fountains, shared in the worship of the goddess. But whether these ships were for the personal glory of the Emperor, which endured for four brief years before his end at the hands of his own servants, or whether they were dedicated to the glory of Diana, is so far unknown. Caligula, thinking that the King of the Wood had reigned long enough, hired a ruffian to provide him with a successor, and this appears to be his only known action in connexion with the sacred grove. It remains to be seen when the lake is drained whether the barges bear any signs of having been used in the service of Diana.

Never in the history of Nemi has such a fate befallen it as that which it will suffer this autumn. Hitherto divers have plunged into the lake, excavators turned up the earth, but the still, unmoving water has remained in the crater. All previous attempts at discovery have been directed towards raising the ships, and they have ended in failure because the barges are embedded in mud, and the timbers to which the chains were fastened broke away. The present century has brought new methods to the problem. It has been possible to observe the position of the barges from the air. From heights of which de Marchi did not dream when he went down into the lake in the diving bell, airmen have been able to look into its depth, and since the water will not give up its secret, it has been decided to remove the water.

An Ancient Emissary.

The Italian Government Commission which considered the problem last year suggested that Nemi should be connected with the neighbouring lake Albano by means of an underground tunnel. The blue Lake Albano, in which a palace of one of the Alban kings is said still to be buried, is more than 1,000 feet deep and lies at a lower level than Nemi, whose waters it could easily contain. This project was abandoned, because there already exists a channel through which the water can be drawn off, and the expense of creating a new outlet can thus be saved. An emissary, so ancient that the date of its construction is uncertain, though it is believed to have been constructed by Roman engineers in the second century A.D., drew off the water that might otherwise in rainy seasons have flooded the temple of Diana, which stood on a level with the lake, protected by the stone buttress. This emissary consists of a tunnel 1,649 yards long, running under the hill on which the village of Genzano stands—opposite the village of Nemi—to the plain of Ariccia, and thence to the sea. Five electrical and engineering firms have offered their services free of charge to the

Government to drain the lake until it is possible to see the prow of the first ship, which is not so deeply sunk as the second. From this point the Government and the archaeological authorities will be responsible for the continuation of the work. The pumping was to have been started in March, and it was hoped that the first ship would be visible in six months' time. Caution is necessary in draining the lake, as it is feared that the ships may be damaged if the water is withdrawn too rapidly. It was expected that the level of the water could be lowered by about one and a half metres for every thirty days pumping.

VIEW ABOVE THE LAKE OF NEMI.

More recently, however, when the present writer revisited the lake, a small erection on the shore was the only sign of activity, and the construction of the funicular to carry equipment from Genzano to the water had not been started. The padrone of the inn at Genzano was busily enlarging his loggia in the hope of an increased number of visitors to Nemi to watch the operations. They will not see the mirror of Diana. The railway and the machinery set up in the midst of the crater will have most cruelly transformed her grove. But the engineers who are draining the lake have undertaken that the water shall be returned to the basin, and since this is composed of the hardest lava and basalt, and the water nowhere runs underneath the banks, there is no fear of a landslip which would alter the familiar shape of the lake and sweep away its gardens.

BRONZE HEAD FROM NEMI.
An early find from a ship in the lake, reproduced by permission from Carotti's "History of Art" (Duckworth).

Nemi will be once more as it was, though, if the experiment is successful, it will no longer be possible to say that the Emperor's barges lie beneath its surface. Some more treasures will be added to the mooring rings which are to be seen at the Museo Nazionale at Rome. It is greatly to be hoped that an elaborate museum will not be erected at Nemi to hold the barges, for if it were decided that such a building necessitated a good road for visitors to the museum, sophistication would surely destroy what the centuries have preserved, and in the discovery of the barges something more precious would be lost.

"DIANA'S MIRROR" FROM ANOTHER ASPECT.

We cannot escape the desire to look into the past. "There is no immortality beneath the moon," but we needs must search the earth for memories of forgotten times, however vainly. If the impression of immortality rests anywhere in the soil, it rests here about the lake of Nemi. The woods are thinner than they were in the days of Caligula, the fields are lonely; no temples rise beside the lake, a mediaeval castle rears its walls in the village of Nemi; but the spirit of the watchful priest seems to brood over the scene, which in the freshness of the spring bears an indefinable imprint of antiquity, and needs no discoveries to bear witness to its long past. The secrets which we dimly discern the quiet earth knows and holds, and will yield them rather to the imagination than to the spade.

It is impossible to do justice to the beauty of Nemi, the loveliness of its desolation; the exquisite delicacy of the colouring of the woods; the grey-blue colour of the lake; the beauty of the flowers which follow each other in the rapid succession of the Italian spring—frail, early snowdrops, short-stemmed crocusses, opening starlike in the grass, violets, deep purple and pale parchment coloured, narcissi bending in the wind, and later sweet scented cyclamen. On the terraces of Il Giardino the heaped ranks of flowers are grown for the market, are plucked and plucked again, yet never seem to diminish; as though the goddess of fertility were still guarded by the melancholy priest, who now unhoused and deprived of his sombre grove, haunts in a milder spirit the solitary fields.

The British Association for the Advancement of Science.

In publishing this month our British Association Number, as in previous years, we give some account of the principal items in the programme. Being held on the present occasion in Glasgow, the meeting provides both industrial and historical interests, of which details are included below.

WITHIN three years of attaining its centenary, the British Association meets this month, for the first time since the new distinction was conferred on its labours by the grant of a Royal Charter. In March last the King in Council approved this measure, a recognition especially fitting to a public-spirited body which experienced so many years of early struggle to establish its position in the popular confidence. As was recalled a few months ago, the term by which the Association is familiarly known—the "British Ass."—was not in its origin the expression of warm affection it has now come to be, and even the leading newspapers joined at one time in the general ridicule.

The 1840 Meeting.

The meeting this year in Glasgow, from 5th to 12th September, harks back to the early days before education was general, and when certain members of the Association were already taking steps to widen the popular appeal of science. Particularly was this pioneer work undertaken among industrial workers, whose numbers in such centres as Glasgow readily provided large audiences. In 1840, the first occasion of the Association's meeting in Glasgow, Sir R. J. Murchison experienced a "glorious day at Arran when I lectured to a good band of workmen,"* while two years previously at Newcastle the famous geologist, the Rev. Adam Sedgwick, had addressed a similar gathering. These meetings took place before the introduction of the "public" lectures which are now a regular feature of the Association's programme. These lectures—not for members exclusively—are arranged on the present occasion both in Glasgow and its neighbouring towns, in co-operation with the Workers' Educational Association, which is associated with the Glasgow University Extra-mural Education Committee in the organization of public lectures and classes.

To-day, when these public facilities are so firmly established, and at a time when the relation of industry and science plays a prominent part in the Glasgow discussions, there is unusual historical interest—even pathos—in the picture of this early occasion as described by Sir John Herschel.† A most brilliant meeting is over, he writes, which "Sedgwick wound up on Saturday with a burst of eloquence . . . of astonishing beauty and grandeur. But this, I am told, was nothing compared to an out-of-door speech, address, or lecture, which he read on the sea-beach at Tynemouth to some 3,000 or 4,000 colliers and rabble (mixed with a sprinkling of their employers), which has produced a sensation such as is not likely to die away for years. . . . It is impossible to conceive the sublimity of the scene, as he stood on the point of a rock a little raised, to which he rushed as if by a sudden impulse, and led them on from the scene around them to the wonders of the coal-country below them, thence to the economy of a coal-field, then to their relation with the coal-owners and capitalists, then to the great principles of morality and happiness, and at last to their relation to God, and their own future prospects."

It can hardly be, to-day, that the British Association feels it necessary to apologise for its interest in practical affairs, yet perhaps in view of the diffidence still felt in certain academic circles an early note in the new programme introduces this connexion. It is pointed out that, keen as its concern for the advancement of science, the Association has never been unmindful or neglectful of the fruits of science reaped by civilization through industry and commerce, and that Glasgow, as among the foremost industrial towns in Britain, provides a fitting background.

Industrial Subjects.

Appropriately, several prominent members are following the President's lead in devoting their papers to the practical aspects of science. Sir William Bragg, K.B.E., F.R.S., will discuss in his Presidential Address the subject of "Craftsmanship and Science," and he is expected to stress the relation of modern physics to national industrial problems. A similar topic has been chosen by Sir William Ellis, G.B.E., who as sectional president in Engineering will describe the "Influence of Engineering on Civilization." In conjunction with members of the Educational Science

* See "The British Association: A Retrospect, 1831–1921." By O. J. R. Howarth, O.B.E., M.A. (published by the Association), page 102.

† *Ibid*, page 101.

section, a discussion will follow on preliminary education for the engineering profession. In the Economic Science section, Professor Allyn Young's subject is "Increasing Returns and Economic Progress," while Professor T. H. Pear (Psychology) is to speak on "The Nature of Skill." The address will be discussed afterwards with particular reference to the present position of skill in industry, a matter in which the facilities of Glasgow should afford favourable assistance. Arrangements are made for members to visit various industrial works in the Clyde area, and to inspect at first hand some representative processes actually in operation. At Greenock, for example, the Royal Naval torpedo factory may be visited, and the Clyde valley electrical hydro-power station near Lanark and the Falls of Clyde is also scheduled.

Another aspect of the Association's programme, the history of Scotland, is arranged appropriately to a meeting in Glasgow. Although the city is more generally known for its industrial activities, in particular for shipbuilding, it is situated in a district rendered famous by the genius of romance, and still more renowned as the theatre of many thrilling events in Scottish history. Glasgow is also the seat of an ancient cathedral of great interest, which alike for its architecture and associations is one of the most important historical monuments in Scotland. The ancient university, too, is an imposing and elegant building, and the various meetings of the Association this month are to be held within its precincts.

Scottish Archæology.

Sir George Macdonald, as its president, will speak on the "Archaeology of Scotland" to the Anthropology section, in which a discussion is also arranged on "Terrace Cultivation in Scotland." The address of general character which Professor J. L. Myres will give on "Ancient Geography in Modern Education" will be localized by a discussion, in the same section, on the teaching of geography in Scotland. Among the excursions of historical interest, provisionally arranged, are visits to Stirling, including the castle, the Wallace monument and Cambuskenneth Abbey; to Paisley Abbey and Coats' Memorial Church; and to Greenock, where the memorial to James Watt is situated. At Rothesay, besides the castle, and St. Blane's chapel, is the Bute national history museum, which contains the recent material from Dunafoil Fort and Cave.

In discussing the Glasgow programme, more especially for those who have not been able to study it in detail, it would give a false impression to suggest that its character is either mainly industrial or historical. On the contrary, the usual wealth of subjects is offered to appeal to every taste. One of the most popular, for example, is likely to be Sir John Reith's lecture on "Wireless in the Service of Education," a new problem dealt with in *Discovery* by another official of the British Broadcasting Corporation, Mr. Edward Liveing, in his series of articles last spring. The variety of the programme is further indicated by the titles of the addresses of the sectional presidents. Incidentally, it may be recalled in this connexion that Glasgow is associated with the new practise of leaving sectional presidents free if they so desire to discuss their topics, instead of requiring a formal address to be read. For Sir A. C. Ramsay, who introduced this departure as president of the 1880 meeting, had given his first scientific paper at the Glasgow meeting forty years before.

The Sectional Addresses.

Besides the subjects already mentioned, the list this month includes: The Volta Effect—old and new evidence (Professor A. W. Porter, F.R.S.); Fluorescence, Phosphorescence, and Chemical Reaction (Professor E. C. C. Baly, F.R.S.); The Ancient Mountain Chains of Europe and America (E. B. Bailey, M.C.); Larval Forms, their Origin and Evolutional History (Professor W. Garstang); The Relation of Physiology to other Sciences (Professor C. Lovatt Evans, F.R.S.); Sex and Nutrition in the Fungi (Professor Dame Helen Gwynne-Vaughan); Next Steps in Education (Dr. Cyril Norwood); The Livestock Industry and its Development (Dr. J. S. Gordon).

On the recreational side of the meeting, the Lord Provost and Corporation of Glasgow will give a reception in the City Chambers. Many excursions also have been planned, and members are offered a choice of a dozen full-day outings on Saturday, 8th September. Among these, a sail may be made on the Firth of Clyde, including Kyles of Bute, round the Island of Arran, and Ailsa Craig; or, alternately, round the Lochs, through Kyles of Bute, and Loch Ridden, to Loch Gareloch. At Millport the Marine Biological Station will be inspected. There are also trips to the famous Trossachs, Loch Katrine and Loch Lomond, via Callander, and to Ayr, the Burns country and Mauchline. Last, but perhaps not least, a day is arranged at Gleneagles and at Turnberry for golfers!

During the meeting two evening discourses will be given as in previous years, the first by Professor Westermarck on "The Study of Popular Sayings," and the second, by Professor G. Donnan, F.R.S., on "The Mystery of Life."

The 1929 meeting will be held in South Africa.

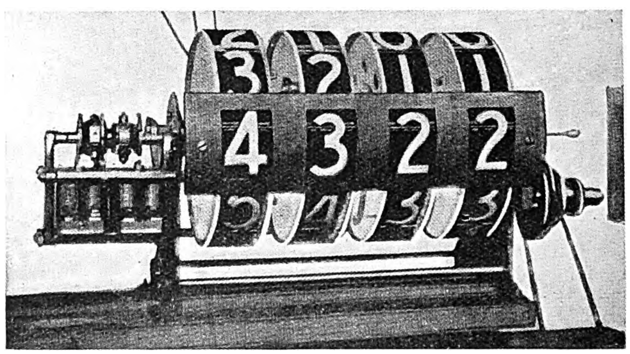
The Totalisator and How it Works.

By Major Ralph Glyn, M.P.

Now that the Racecourse Betting Act has received the Royal assent, the bill having been introduced to Parliament by the author, it is appropriate that the invention known as the totalisator should be described in DISCOVERY. *Technical considerations only are dealt with, the moral aspect of betting being a question outside the scope of this journal.*

"TOTALISATOR" is an Australian word coined to describe the application of electricity to the old-fashioned "Pari-Mutuel" method of betting. The Pari-Mutuel system depended solely on human agency for its operation, and consequently there was always a danger of mistakes being made. In its simplest form the Pari-Mutuel consists of numbers in series, which are detached from a block in accordance with the number of unit bets invested on any particular horse, each horse having a separate series of numbers allotted to it. This method provides an automatic check on the total number of unit bets invested on the various runners. When the flag at the winning post fell the total number of units were added together, and in accordance with the investment made on each horse the odds were worked out, deducting the cost of operation and any taxes or charges due to the State and the racecourse company. The Pari-Mutuel can only operate in one place, and there must therefore be different pools in accordance with the number of Pari-Mutuel installations on different parts of the course. A five shilling unit is, for instance, more suited to the expensive enclosures, as is a shilling unit to the cheaper enclosures. There was therefore no uniformity, necessarily, in the odds paid out on a particular horse in one ring or another.

By the application of electricity it is possible to have a number of places in all parts of the course where betting can be transacted, and all having a common unit, say two shillings. Multiples of this unit can be arranged for, and the electrical machinery automatically creates a common pool of the total number of units staked, some being at face value and others in multiples of that unit. The totalisator system also guarantees the payment of winning bets, and persons using the machine run no risk whatsoever of not obtaining their money. Since a known percentage of the takings of the totalisator will be deducted to meet the betting duty, the costs of operation and construction, and to provide a fund for the benefit of racing, it follows that this system of wagering is really "co-operative betting." It enables the man who stakes his two shilling bet to obtain actually the same odds as the individual whose stake is five or twenty pounds as multiples of the unit. The poor man, in other words, will profit by the total amount of money invested by all persons using the machine from different parts of the course, and may be certain that he will be paid out the actuarial and therefore the fair odds upon his selection, less the advertised and legal deduction.

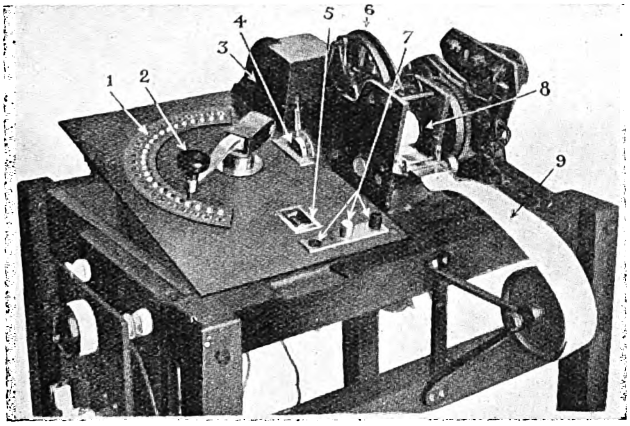


HORSE UNIT OF A SMALL TOTALISATOR.
The revolving drums are contained in the machine-room behind the indicator board, and only the figures giving the odds are exposed to exterior view. A unit of this type is required for each horse.

There has been some doubt as to whether the cost of installing up-to-date machines is possible in this country on many racecourses, owing to the fact that race meetings are held on so few days in the year. To some extent this criticism is justified, but there are certain courses where it will undoubtedly pay to instal the necessary machinery and plant, to cater for the race-going public who use these courses in considerable numbers for certain well-known race meetings. For instance, at Newmarket, which is the only racecourse in this country owned by the Jockey Club, a rough estimate was made that the installation would cost £13,000 for the "Rowley Mile," and £7,000 for the "July Course." These figures do not include the cost of buildings: if plain but solid buildings, suitable for housing the machinery and providing the necessary number of betting "booths," were erected, the total cost for the two courses would be approximately £30,000. The similar costs on other

racecourses will vary in accordance with their size, the number of enclosures to be catered for, and the average number of persons who, it may be anticipated, will attend these meetings. Obviously, if racecourse authorities wish to take advantage of the construction of buildings to improve their stand accommodation, the cost will be proportionately greater.

A good method of lay-out places the central plant at a point between the paddock and back of the stands, and on this building the main indicator board is affixed. Repeater boards can be erected on the different parts of the course, and by electrical connexions instantaneously register the totals appearing on the main indicator board. Radiating out from the central building are buried cables to the ticket-issuing machines dotted about in the various enclosures, and also on the different floors of the stands. By this latter arrangement persons can make their bets without leaving the shelter of the stands. As a rule the pay-out counters are on the reverse side of the building where the ticket-issuing machines are located. Experience will prove what proportion of ticket-issuing machines will take wagers of the unit value itself, and how many machines there should be of twice, thrice, ten times, etc., the value of the unit.



TICKET-ISSUING MACHINE FOR TWENTY-FOUR HORSES.

The numbers in this photograph denote (1) Holes each corresponding to a horse, (2) selling handle, (3) opening for the printed ticket, (4) drum bearing numbers of the races, (5) counter registering number of tickets sold by the machine, (6) ejector of tickets, (7) switches controlling machine, (8) printing gear, and (9) paper ribbon.

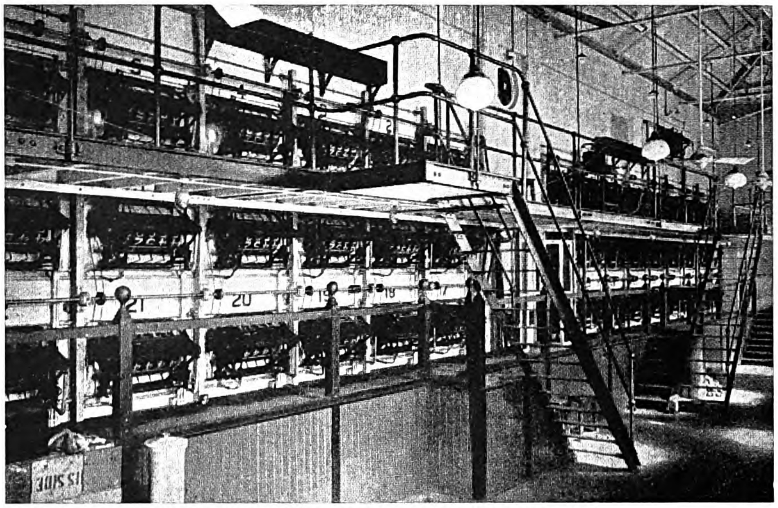
The cost of each installation is to a large extent governed not only by these considerations, but by the maximum number of starters that might run in any particular race. It might be, for instance, that the average number of starters for a particular race on one day of the year far exceeds the average number of starters for any other race on any other day when a meeting is held. It would, however, be necessary either to provide indicator boards that would account for the largest possible number of starters, or else to limit the number of starters. Therefore the whole plant must be designed to suit the maximum requirements, although the machinery for certain races might only be used once or twice in the year. If the average number of starters on any course seldom exceeds fifteen, the total cost of the machinery can be worked out, but if on occasion there are up to thirty starters it would mean that the cost of the machinery, as distinct from the buildings, would be just twice as much. This is a point which deserves very careful consideration, and must be a limiting factor in the use of the machine. If the Pari-Mutuel system is adopted it is not so strictly limited in its scope, because it is always possible to have extra series of numbers and additional places on the indicator board. With the electrical totalisator it means the actual duplication of the plant.

It will be recognized that until the Racecourse Betting Control Board is established it would be impossible for me to describe any particular machine, since the Board must have absolute freedom to decide which is the best machine for use in this country. There are, to my knowledge, a good many firms at present engaged in experimenting, and it would be a great mistake to assume that the British race-goer's psychology is comparable to that of race-goers in other countries. For instance, the British are accustomed to make their bets in accordance with the odds offered, and if a machine could be made which, instead of registering the total number of bets, recorded what were the equivalent odds of that total number of bets on any particular horse, it is more than likely that such a machine would be best suited to British requirements. During the war a great many firms were engaged in the manufacture of very delicate electrical plant for use in the navy for fire control, when absolute accuracy and strength were essential requirements. I am personally satisfied that these firms will very soon be able to produce a machine that will offer big advantages over anything now in existence.

As *Discovery* is largely read by persons who have more mechanical and scientific minds than mine, I hesitate to give a detailed description of the method of the actual working of the electrical apparatus. It can, however, be stated that the following procedure will have to be common to all machines, whichever may be the type selected by the Control Board. The ticket-issuing machines will have to be capable of operating at high speed, and should any one of them break down the fact will have to be automatically notified to the central building, and

each machine must transmit an impulse to the central plant every time a ticket is issued to a person making a bet.

The totalisator cannot be responsible for the mistakes made by individuals who in error put their money on a horse that they did not intend to back. Also no ticket can be issued unless its full value in cash has been paid. The most modern form of ticket-issuing machine enables bets to be made for a win or a place by the simple operation of shifting the knob on the handle of the operator's lever. Electric contacts enable these different classes of bets to be registered with the central plant. By a simple arrangement situated in a specially constructed box, the turning of a lever cuts out all circuits and no further betting can be done the moment the flag falls. Whilst the race is being run the totals on each horse are calculated, and the moment the winning numbers are "up" and the "all right" signal given, successful backers can obtain their dividends at the pay-out windows. It takes less than two minutes for the central totalisator office to register the proper amounts to be paid out on the winner and "place" horses.



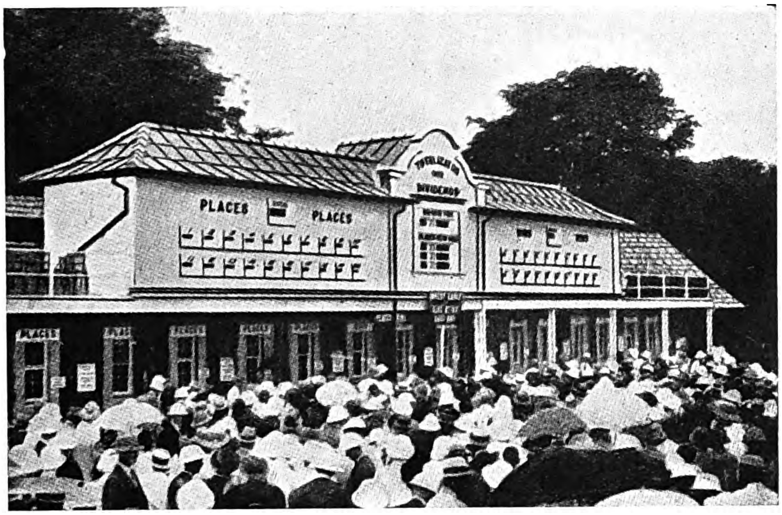
INTERIOR OF A TYPICAL MACHINE-ROOM.
This shows the interior arrangement of the board, on which the figure machines are placed in rows. The slots exposing the figures are seen in the photograph opposite.

As far as the central plant is concerned, each horse has a distinct set of machinery, and "place" betting requires a duplicate set of machinery of a similar character. Each "horse machine" is directly connected to the indicator that gives the public the total amount invested on all horses running in the race, which forms the pool. Since the number of bets on each horse is shown on a board, and in addition to these figures the total number of bets on all horses on a separate indicator, it is quite possible to know what are the odds at the moment against any horse. It is merely necessary to deduct the authorized percentage from the pool, then deduct the number of bets on the horse in question from what is left in the pool, and finally to divide the remainder by the number of bets on the horse, this giving the odds against the horse in question. It may sound complicated, and as the numbers are constantly changing the exact odds against all the horses at any one moment can only be guessed. It is the practice on most foreign courses for a printed sheet to be issued every few minutes giving roughly the odds against the various horses.

If British inventive genius can produce a totalisator which does this calculation automatically and shows clearly to the public the odds against all the horses all the time, obviously that machine will be greatly superior to anything as yet in existence. Up to the present time the totalisator in general use in British Dominions and foreign countries is Australian in its origin, and has been in use for a number of years, with entirely satisfactory results as regards accuracy, mechanical dependability, and ease of operation. It is advisable, if possible, to employ a highly trained staff to take charge of the ticket-issuing machines and to be responsible for accurate paying out. The latter task is not as difficult as it might seem. The pay-out windows, as I have said, are on the opposite side to the ticket-issuing windows, and all payments are of similar amount, varying, of course, as regards the individual recipient with the number of tickets presented for payment.

In France and other countries a great deal of the racing takes place on a limited number of racecourses, and meetings are frequently held throughout the year. In England the practice has been to hold perhaps two or three meetings on the same day at widely separated racecourses. Some of these racecourses can always count on large attendances for the majority of the meetings, and on these courses an electrical totalisator will probably pay its way without difficulty. The problem, therefore, that confronts a racecourse is to consider whether or not the average attendance throughout the year will justify the expenditure involved in erecting these machines. From the point of view of the Racecourse Betting Control Board it will be of the greatest importance to devise some system

whereby, if possible, the cost of these machines can be reduced, by transporting from one meeting to another as much of the machinery as is capable of movement. There is no reason why all the ticket-issuing machines, for instance, could not be moved from place to place. The main installation in the central building will have to be permanent, together with the various "horse machines" for win and "place" betting and their connexions to the total investment indicator. The buildings in which the ticket-issuing machines are placed should as a rule be of a permanent character, although in certain cases temporary buildings could be erected over the places where the cable connections emerge from the ground. This practice will undoubtedly save a good deal of expense, although my own opinion is that a great many racecourses will be content with the installation of the old-fashioned Pari-Mutuel manual system, which costs very little to erect and is completely mobile in two or three lorries.



TOTALISATOR BUILDING AT COLOMBO, CEYLON.
Here is seen the board which gives particulars of the horses and the odds offered by the totalisator. Each slot corresponds to a specific horse in the day's racing programme.

In any investigation of betting machinery it is always important to consider the problem of betting away from the course. This form of betting is a very large proportion of the whole volume. The practice to-day is for a large number of starting-price book-makers or commission agents to have their offices in the larger towns all over the country. Our existing laws do not prevent these bookmakers to receive wires and telephone bets and also commissions sent by post, because the law by which the bettor may on no account "resort" to these offices for the purpose of making a cash transaction was on the Statute book before the invention of the telephone. In other words, credit betting is allowed, although it is certainly a pernicious form of gambling, and has been the cause of much of the trouble that comes from betting. The Street Betting Act has not been a success because quite illegally a large number of slips accompanied by cash reach these offices on a day when races are being held. The odds at which the bets are paid by these starting-price bookmakers' offices are determined by the odds offered by the course bookmakers at the start of the race. Hence these odds have but little relation to bets received by the commission agent, and a considerable profit is usually assured to the various bookmakers through whose hands the transactions pass.

It is believed that when the totalisator is established the starting-price will be governed as a result of the public's use of the machine. The present official starting-price is settled by certain persons connected with the sporting Press who work out on the course what the figure should be; on the whole they have done their work very fairly and honestly, but, of course, their decisions are not governed by means so accurate as the scientific betting provided by the totalisator.

The Racecourse Betting Act provides that the Betting Act of 1853, and certain other statutes, shall not apply to any racecourse that is "approved" by the new statutory body known as the Racecourse Betting Control Board. It will be the business of the Board to make the condition of granting a certificate contingent upon the racecourse undertaking to observe certain rules of proper conduct.

Totalisators established on "approved" racecourses can only be used for betting on horse races that take place on these racecourses, and cannot be used for races taking place elsewhere. Furthermore, for the first time it is laid down in this Act that persons under seventeen years of age shall not use these betting machines. No limit has been laid down as to the amount that can be properly deducted from the pool, but about 8 per cent from the pool should be sufficient to meet the Government tax, and to provide the necessary funds to repay in time the cost of con-structing and erecting the machines and for their operation. In addition the funds will be used at the discretion of the Racecourse Betting Control Board for furthering the interests of racing, of horse breeding, and in certain cases applied for charitable purposes.

Roman Antiquities in Provence.

By R. Gordon George.

The final volumes have now been published in France of a series of studies on the Roman monuments undertaken by Professor Camille Jullian. In reviewing the recent work of French archaeologists, Mr. Gordon George traces in particular the influences which are reflected by the ancient remains in Provence.

It is the double business of the archaeologist to understand the excellence of antiquities and to use them as documents of history. A knowledge of Provence is part of a study of ancient periods, and part of a study of art. The world of culture, therefore, is indebted to those French savants who have been working in that field, and more indebted because they have been working admirably.

We owe a tribute to the archaeologists of France. It is now nearly two hundred years since Montfaucon produced his pioneering work on Roman remains. At the end of the eighteenth century scholars accompanied Napoleon to the Nile, and in their survey of Egyptian monuments opened up to Europe a new world of knowledge. It was again a Frenchman, Champolleon, who was the first to decipher Egyptian hieroglyphics. Not many years later Botta excavated the great Assyrian palace whose monumental gateways and bas reliefs are now part of the Louvre collections. In elucidating the history and arts of Babylon and Elam, Frenchmen have done their share. Frenchmen, again, were in charge of the excavations at Delos and Delphi. Pottier, the keeper of Ceramics at the Louvre, is a name that accompanies the reputation of Pérot, Chippiez and Colignon. In the French colonies of Tunis and Algeria excavators have been busy. The gigantic Brahmin temples of Cambodia have been cleared from jungle. The great Salomon Reinach is himself a Frenchman; in our own time, also, Monsignor Duchesne, and a Belgian impregnated with French learning, M. Cumont, have each been supreme in separate fields of research in Rome.

THE TRIUMPHAL ARCH AT ORANGE.

Orange was founded to wipe out the memory of a Roman defeat by the Gauls, and the arch illustrates Caesar's victories. One of the carvings shows a pair of trousers in token of contempt for the savages who wore them!

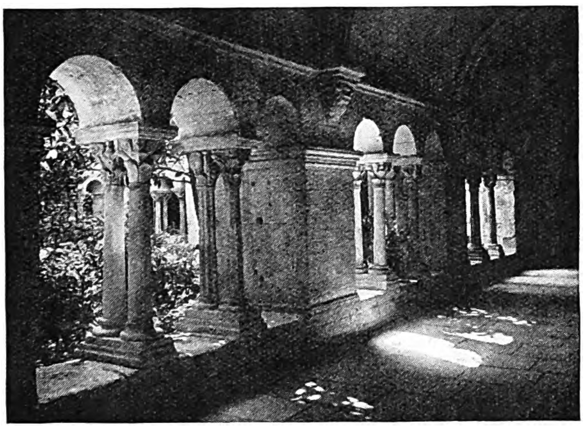
The French have an exceptional stimulus in the fact that their own country has furnished remains which carry the story of man back from our own days into the dark night of time. Dolmens, menhirs, and caves once containing objects from the neolithic age are to be found in the neighbourhood of Arles. And since Gallia Narbonensis was a Roman province, since Caesar conquered Gaul, France has a national interest in Roman monuments. These have been the subject of a profound and brilliant study by Professor Camille Jullian of the Collège de France. The first two volumes appeared in 1906. The last two of eight were published in 1927, a study of the Emperors of Trèves. In his succession of crowded chapters, he builds up his immense and concentrated learning into a story so picturesque that we look clearly at the life of two thousand years ago. There the ancient settlements of Provence are seen in the multifarious activity of a busy and cultured people civilizing barbarians. Much of M. Jullian's work is original; here and there it is being supplemented by that of others, such as Commandant Espérandieu, the Abbé Sautel, and M. Benoit, the archivist of Arles. The work of the archaeologists may be traced in the proceedings of the Congrès Archéologique which has met, now at Vaison, now at Aix, now at Nice. Here and there it was prepared by the work of other savants. Not least of these is M. Michel Clerc, Professor of History in the University of Aix. His "Aquae Sextiae" appeared in 1916, following his earlier study of the campaign of Caius Marius in Provence. It traces the history of Aix to its obscure origins.

Livy was the most ancient authority on this subject. Flaccus, he said, who waged a campaign there in 125 B.C., first reduced the Transalpine Ligurians, when he was sent to the help of the Massilienses, whose territories were being ravaged by the Salluvian Gauls. Florus, writing two centuries later, expresses himself in vaguer terms, and the statement is repeated still more vaguely by other writers. Flaccus was succeeded in 124 B.C. by Sextius Calvinus, whom Strabo expressly

states to have been the founder of Aix, and to whom Diodorus Siculus refers, doubtless rightly, as a consul. It must have been his son or grandson of whom Cicero speaks as *ingenio et sermone eleganti*; and we cannot but admire the taste of the man who chose this spot for his settlement. In the broad and fruitful valley which lengthened on the road from Fréjus to Arles, the olive, grey-leaved and glittering, spread out among hills on which the vine and cypress and the villa were awaiting to be set out for man's delight, and to recall the charms of Attica or of the Campagna; above rose the summit of Mons Victoria which, from 102 B.C., was to record the great battle which Marius won against the Cimbri and Teutones on the plains below. The mistral was tempered by the slope of the northern hill, and across the rich roll of plain and rise, Marseilles could be reached in two or three hours on horseback. In this delightful spot Sextius Calvinus found one of those springs of medicinal water which the Romans, with their love of the bath, prized wherever they found them. Nature had prepared a spot to which history now points her own finger, and Aix was well suited to be the first Roman settlement in Gaul. Whether or not Sidonius Apollinaris, when he speaks in his odes of the trophies of Aix, was referring to anything more exact than the victory of Marius, certainly temples and statues of the gods were soon gathered in a place so attractive and so cherished. Equites and senators made Aix their home, and gradually it grew splendid with their tombs; not until the time of Augustus, however, was the settlement fortified.

Of this period few memorials remain. Many were incorporated into the old palace, but during the eighteenth century they too disappeared. The clock tower is undoubtedly the remains of a Roman campanile. Coins have been found, but, though rare, they cannot be called precisely informing. Inscriptions on stone, reliefs on terra cotta plaques. and Roman capitals are collected in the museum, and beautifully reproduced in Professor Clerc's book. But the other settlements are all much closer to the Rhone.

Arles was no doubt the most important of them. It had in those ages something of the success which Marseilles has now, but it was important too as a centre of civilization, a centre where, as in Vienna and Budapest to-day, culture was enriched by the traffic of the orient with the west. It owed its first greatness to being sought out by Eastern traders. It is thought that the very name of the Rhone, Rhodanus, was due to traders from Rhodes.



CLOISTERS OF ST. TROPHIME, ARLES.

The churches built in the early middle ages in Provence are often indistinguishable from the architectural work of the Romans, so much were their builders influenced by the classic style.

The ancient settlement of Arles was established with rights and privileges as the centre of a Roman colony in 46 B.C. by Julius Caesar, who made it the headquarters of the sixth legion, giving it the name of Colonia Julia Paterna Arelate Sextanorum. The bull, which was Caesar's own emblem and that of the sixth legion, was carved upon the monuments of Arles, which to this day brings its bulls from the Camargue to fight in the Arena. In the first century, it rose from the surrounding marshes with much of the eminence that to-day makes its walls and towers so striking from the hill of Montmajeur Built of stone, under the sign of the bull, the new city had the massiveness of Rome. No people in the zenith of its power built so much as the Romans. Building was a passion with them, a manifestation of their force, a claim for everlasting permanence. And this, under the first emperors, was made in every colony. Grand and strong, their buildings are distinguished by massiveness, wealth and usefulness. Their architecture insists on vast materials. Its essence is the arch, as seen at Arles or elsewhere, in its bridges, aqueducts, gates, sewers, markets, theatres, baths, arenas, palaces and temples. Primitive but final, the arch is kindred to the dome of heaven which it mirrors, and human art can go no further than where sky and nature meet. No pointing spire nor Gothic soaring are more divine. This majesty was made the inheritance of Arles, and the order it implied gave unity to the style of the new city. Powerful corporations or *collegia* developed its old importance as a focus of traffic, and it became the wealthy emporium of the grains of Gaul.

Commerce and culture are sisters, and in the first century the citizens of Arles took an elevated pleasure in the things of the mind. From Greece, as we have seen, Arles took the fineness and purity of taste with which her statues, pictures, bas reliefs, altars, cups,

vases and candelabras were drawn and modelled. The harmony of lines which to the Greek became one of the very forms of thought (for he more than any other had the passion for beauty of lines and proportions), marks those fragments of triumphal arches which Arles still preserves in her museum and her Roman theatre. Greece gave to Arles her famous Aphrodite, now in the Louvre. It gave that head of Diana or Ceres, sculptured about the year 400, and described by Reinach as the "finest of ancient marbles discovered in Gaul." To Greek influence were due also the altars of the theatre, two with wreaths of oak leaves, one with a garland of laurel leaves held by swans. Arles thus, in the first century of our era, inherited from Greece the phases of art which Rome itself was to follow. Roughness, then grandeur, then grace, and at last voluptuousness have marked the rise and fall of most civilizations. In Hellenic art this was particularly clear. At the beginning when the influence of Aegina was supreme, it was hard, full of vigour, archaic. In the age of Phidias, it has nobility, severity, calm; and then a change is felt. A delicate sensuousness takes sharpness from the chisel; graces appear instead of majesty, and one feels that like the Pygmalion of the myth, the sculptor loves his Galatea not less than his art. As it leads on to the age of Praxiteles, Hellenic sculpture speaks more and more to the imagination and the senses. Arles knew of all these, but it treasured most the works of the age of Pericles.

SCULPTURED HEAD FROM VAISON.
The most beautiful Roman remains at Vaison are the statues in the local museum, of which the piece here illustrated, a woman's head crowned with laurel, is an example.

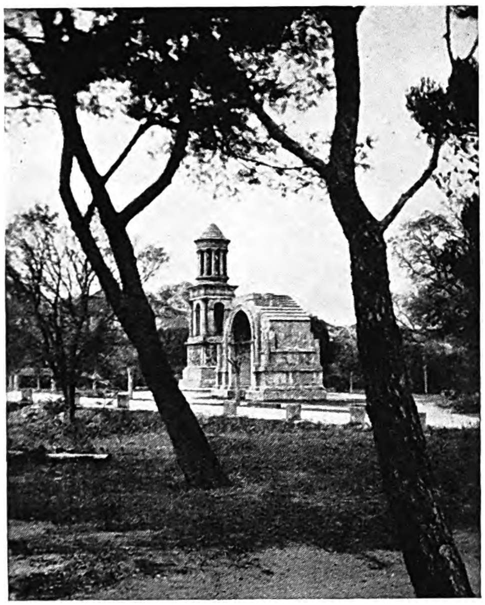
Lovers of art, the great merchants of Arles had a link also with literature. Pliny the Elder made mocking references to Pompeius Paulinus as a *nouveau riche*, but his daughter married Seneca who dedicated to the old merchant the Treatise *De brevitate vitae*, and the virtues of the family are celebrated in the *Annals* of Tacitus. Among the sons of Arles, Clodius Quirinalis taught eloquence at Rome in the age of Claudius, and the philosopher Favorinus was the friend of Plutarch and Epictetus.

Fifteen or twenty miles across the river was Nîmes. "Strange and attractive city!" writes Jullian. "Its origin is mysterious, it draws from the past a subtle charm, and its life is difficult to realize." It was the holiest of all the cities of Gaul; its sacred spring, *deus Nemausus*, issuing from one of its highest hills, now in peaceful eddies, now rushing in waves of foam, gave a constant sense of the presence of the gods, and nowhere did loyalty to the emperors take so easily the form of a religion. Therefore was a temple raised to survive to our own times as a memorial to the grandsons of Augustus, and the basilica was a memorial to Trajan and Plotina. The amphitheatre, though not so large as at Arles, is in better preservation. A gate, still known as the Porte d'Auguste, survives also to our own time. Here arose the family of the Emperor Antoninus, whose spirit was that of Nîmes itself. It was dominated by a religious and dutiful middle class, devoted to family life and practical affairs, and this answers the ideal of the Antonines.

Not unsuitably, therefore, do we think first of its temples, of which one is far the finest survival of Roman temples anywhere. "The *Maison Carée* of Nîmes is a jewel," writes Professor Jullian, "with its dimensions so well proportioned, its component parts so well adjusted, with the fine colonnade which surrounds it without weakening its effect, with the broad portico through which the light pours in waves, with its capitals of olive leaves, sculptured with a chisel delicate and sure. But in spite of all, when the eye lingers long, the final impression is cold and spiritless. And I recognize too well the meticulous measurement, the patient toil of a faultless pupil of the Greek masters. What perhaps give it most life and most attraction is the blue sky which at once surrounds and penetrates it, it is the patina, the gilded imprint which have been left upon it by twenty centuries of southern sun." It was just this excellence and this want which typified life as a whole under the Roman Emperors. We must beware of idealizing the life of either ancient Greece or ancient Rome, while admiring the beauty and appreciating the interest of the charming monuments of Provence. The two fine statues in the *Maison Carée*, one of a lady, one apparently of the goddess Ceres, are each more lifelike and individual than the head of Venus there, which is in fact a reproduction of the Venus in the Capitol. But as we look at these

we see that, exquisite as was the feeling for line, and therefore for drapery, the face lacks animation. The fires of vitality refined to a spiritual strength are something ancient art rarely knew. It hardly moved aside the muddy vesture of mortality. It showed its fuller felicity in the proportions of architecture. And though it has not survived in the perfection of the *Maison Carée*, the temple in the gardens at Nîmes has a still greater charm in the proportions of its walls to one another and to the vault of its roof. Its niches with their entablatures above, alternately curving or pointed, are also beautifully set, and it is to be noticed that its slabs and the stones of its vaulting were so well cut that they had no need of cement.

A model of the *Maison Carée* survives, smaller and blacker, at Vienne. Vienne, city of the Allobroges, knew itself to be, and named itself, Celtic. It was the centre of a great realm, mistress of Grenoble and of Geneva. There the original inhabitants began to adopt the habits of the senators. Its luxury astonished the Romans themselves. When the generals of Vitellius arrived from Germany, they redeemed it from pillage, as Tacitus makes clear, at the cost of several million sesterces. Martial designated the town as beautiful and rejoices that books are its chief delight. Of the treasures of this epoch many are gone to Lyons, or the Louvre. A famous mosaic is in the gallery at Grenoble; but there are many fine bas reliefs, and a notable head in ivory. Among other curious remains at Vienne is an obelisk built on the square roof of a quadruple arch; this was raised in the ancient circus, as the obelisk at Arles makes the site of the stadium there.



THE MAUSOLEUM AT SAINT-RÉMY.

With the adjoining triumphal arch, the mausoleum forms a delightful group among the trees. Recent excavations have shown here the site of a Roman temple. (Copyright photograph by M. Amiel, Aix-en-Provence.)

But scattered through Provence are many remains of the Roman Empire. At Die, there are the remains of a Roman arch built into the mediaeval ramparts, and an altar for the sacrifice of bulls; at Carpentras there is a triumphal arch with reliefs of captives on either side; between Apt and Bonnieux there is a Roman bridge over the Calavon, but the statues from Apt are at Chatsworth; at Vernègues there are the remains of a small temple, attached probably to a neighbouring villa; at Cavaillon there are two arches, one of which has two graceful winged and draped figures in low relief among the remains of one of the most delightful of conventional designs; at Saint-Rémy, a triumphal arch and a mausoleum make a delightful group among the trees. This arch has all the qualities which the age of Augustus gave to architectural style and ornamentation. Not only the harmony of the composition, but the carvings of oak apples, grapes, pear, pine-cones and pomegranates are charming: the mausoleum has four interesting bas reliefs carved on the stylobate; on one side an engagement between horsemen; on another a fight round the body of a fallen warrior; on the third a combat beside a river which is symbolized by a river god; and on the fourth the hunting of a boar. These are well designed, and full of vivid incident. The remains of Saint-Rémy are built upon the ancient Glanum, where recent excavations have shown the remains of a Roman temple and have led to the discovery of an altar dedicated to Sylvanus.

There still remain the great monuments of Orange, Vaison, and the Pont-du-Gard. The Pont-du-Gard was part of the aqueduct designed to bring water from Uzès to Nîmes; of this aqueduct many divided portions have been traced. It was built probably at the command of Agrippa, the son-in-law of Augustus who was endowed with something approaching sovereign power; this power he exerted so as to leave a lasting civilization where government and private life would both be happy. The Pont-du-Gard is his great monument. Its three tiers raise it to the height of over 160 feet above the waters of the river.

At Orange, both arch and theatre are magnificent. No other Roman theatre, except that at Aspendos in Pamphylia, retains its high façade. This one rises to 135 feet, and gives back a clear echo, even to low tones, as to the cooing of the doves flying among its heights. In the central niche was placed the statue of the Emperor; and there are traces that show how thoroughly the architects understood the needs of both players and spectators. Apart from the excellent arrangements of acoustic, the wall gave shelter from the mistral, and huge awnings raised on masts gave

shade. Orange was founded by a colony of veterans of the second legion, stationed there, according to M. Jullian, to wipe out the memory of a defeat of the Romans by the Gauls. The arch is carved with scenes therefore of the victories of Caesar on land and sea, and among them are trophies and ensigns of the Gauls, including a pair of trousers, in token of contempt of the savages who wore them. *Tempora mutantur.*

The Vaison Museum.

Orange has long been famous, but Vaison, some thirty miles away to the east, may almost be called the discovery of our own generation. It has been the especial study of the Abbé Sautel, whose taste and judgment deepen his erudition. His book on the Roman cities in the Rhone valley is the best introduction possible to the ancient province, and the same high standard is maintained in M. Benoit's book on Arles. M. Sautel has now produced larger and more learned volumes on Vaison in which everything that bears upon the excavations there is set out with a clearness never sullied by his learning, though it is meticulous. At Vaison there is also a theatre, there are the remains of villas, of baths, and of an aqueduct. There is also a Roman bridge. But the most beautiful of its remains are the statues in its little museum. These are beyond comparison the best in Provence, even though the Roman replica of the famous Diadumenos of Polycleitus was acquired by the British Museum when it was discovered in 1893. But the head crowned with laurel in the ruins of the Roman houses is not unworthy of comparison with the head at Arles. The statues of Sabina, of Hadrian, of Tiberius, of the emperor in a cuirass, and not least the headless figure in a toga, attest sufficiently the taste and dignity of Vaison, which is designated by M. Jullian as the most elegant in the province, the one which tasted most of the luxuries of Roman government.

So thoroughly did the Church adopt the Roman monuments that the architectural work of the Romans is often indistinguishable from that of mediaeval Provencaux. One sees this at the Cathedral of Vaison, at St. Gabriel near Saint-Rémy, and in the Porte d'Orange at Carpentras. Two or three centuries ago, the temples at Nîmes were used as churches, and that of Livia at Vienne was known as Notre-Dame-de-la-Vie. Sometimes the wheel has gone round further, for the museum at Arles was built as a church. And even the great new churches of the early middle ages gained so much from the Roman survivals around them, that the portal of St. Trophime at Arles, and the far more glorious one at St. Gilles, surpass their rivals because of their classic temper. It is a classic harmony likewise in the beautiful cloisters of Arles and Saint-Rémy, of Vaison and Montmajeur. It was not unnatural that the Popes in exile should come to Avignon, and a building of Paul V in front of the Popes' palace give Provence a link with Rome's development of the classic revival in the sixteenth century. And it must not be forgotten that the Comtat Venaissin was a papal territory up to the French revolution.

In what form did the victorious religion come to Provence? Stubborn tradition traces it back to the personages of the Gospel; and it is clear that the people failed to distinguish between Caius Marius and the Maries, whether Madonna or Magdalen. An ancient legend pictures the Magdalen arriving with two other Maries and a St. Sarah, their Ethiopian servant, in a ship guided by winged angels to where now rises the fortified Church of the Saintes Maries, and the chapel of the Sainte Baume is venerated also as the home of St. Mary Magdalen. This touching veneration of the penitent sinner is less wonderful than the undeniable truth that the faith inspired in a few poor Jews by a discredited Teacher traversed the Roman Empire so rapidly that it spread in Provence in the same days as the Roman culture which, in the course of three centuries, it wedded with its own. Roman Provence is replete with Christian antiquities. The museum at Arles has the finest collection of Christian sarcophagi outside the Lateran; and the simple words *Pax eterna*, written upon one of them, had—will always have—a stronger hold over the human mind and heart than every memory perpetuated by the Romans in their greatness.

Pulverized Coal for Ships.

THE Glasgow correspondent of *The Times* reports that an important development in marine engineering, which should react favourably on the British coal industry, is to be introduced on the Clyde. In a cargo-carrying steamer of 8,000 tons deadweight which the Berwindmoor Steamship Company of Liverpool has ordered from the Blythswood Shipbuilding Company of Glasgow, pulverized coal will be used as fuel. It is stated that this will be the first ship built or owned in Britain in which this method of using coal will be introduced.

As the machinery and boilers will be of ordinary types, comparisons will be possible with existing installations regarding economy and efficiency. The raw coal will be carried in ordinary bunkers, and will be pulverized on board by a special plant.

The Bicentenary of Captain James Cook.

By R. N. Rudmose Brown, D.Sc.

Captain Cook's bicentenary is to be celebrated in Yorkshire on 8th September, but the profound importance of his geographical discoveries is not yet generally appreciated. Cook's long voyages were made possible by his methods for prevention of scurvy, at that time a universal disease among sailors.

THE great age of discoveries had ended before the close of the seventeenth century. In two centuries the search for the eastern and the western routes to the Far East had revealed many of the borderlands of the Pacific Ocean, but the ocean itself was little known. During the late seventeenth and early eighteenth centuries voyages of pirates and buccaneers did more than others to score this great blank on the map, but much of their work was vague and their reports were inconclusive. Trade was still the chief motive in exploration, but the age of geographical voyages as apart from purely economic ones was dawning when James Cook was born two hundred years ago, on 28th October, 1728, in the Yorkshire village of Marton, on the edge of the Cleveland Hills.

A Southern Continent.

One of the problems exercising the minds of cartographers, not to speak of traders, in the eighteenth century, was the existence of a Southern Continent. It was not a new problem. When the Greek astronomers conceived the world to be a sphere with Europe and Asia in the northern hemisphere, they postulated a southern continent for the sake of balance and symmetry. Alter Orbis of the ancients was the beginning of the mysterious Southern Continent that was sought for assiduously and hailed in many lands and unimportant islands from the sixteenth till the eighteenth centuries. Magellan, in his discovery of Tierra del Fuego in 1520, was the first to sight what might be part of a southern continent, but his discovery was regarded merely as confirmation of the great land, based solely on credulity, which appeared on such globes as those of Leonardo da Vinci and Schöner in 1515. Fuegia was not displaced from its position of fame until Drake in 1578 found it to be an island, and even then the significance of his discovery was overlooked. New Guinea, the Santa Cruz Islands, the Solomon Islands, New Holland (Australia), Espiritu Santo (the New Hebrides), Staten Island (New Zealand), Easter Island (if this was Davis Land, which is improbable), Bouvet Island (Cape Circumcision), Samoa, the Crozets, and Kerguelen; each at one time or another was hailed as the outpost of the reputed Southern Continent, so great was the obsession of its existence.

By the third quarter of the eighteenth century the postulated continent had shrunk a little in size and faded slightly in reputation, but there was plenty of room on the globe, even in temperate latitudes, to contain it. It held out hopes of vast new trading grounds, and one estimate put its population at about fifty millions.

Alexander Dalrymple, who was Hydrographer for thirteen years after holding a similar post under The East India Company, published in 1767 a chart of the South Pacific showing discoveries previous to 1764, accompanied by a work in which he sought to prove his belief in a southern continent. The chart showed no land south of latitude 30°S. between South America and Van Diemen's Land except vague indications of land (which have since proved non-existant) west of the 90th meridian and the coast of Staten or Staat's Land in about 170°E. These lands suggested the edge of a continent. To the northward of this great empty space lay signs of land on Quiros' track (1606), Tasman's Rotterdam Island (Tonga group) found in 1643, and Roggeveen's track of 1722. In the Indian and Atlantic Oceans there were comparable blanks in even moderately low latitudes. Bouvet Island (Cape Circumcision, 1739), merely supported the belief in a continent, and it is doubtful if South Georgia had really been sighted at that date.

Dalrymple's Chart.

It is true that the modern charts show great areas of empty ocean in the same latitudes as Dalrymple did, but that is the outcome of knowledge; in his case it was the result of ignorance that allowed imagination full scope. The voyages of Byron, Wallis, Cartaret, and Bougainville in the same decade that saw the publication of Dalrymple's chart focussed attention more closely on the Pacific by the discovery of new islands and strange peoples, but did nothing to investigate the southern part of the ocean. The avoidance of the South Pacific was no doubt largely due to the necessity for a vessel bound westward

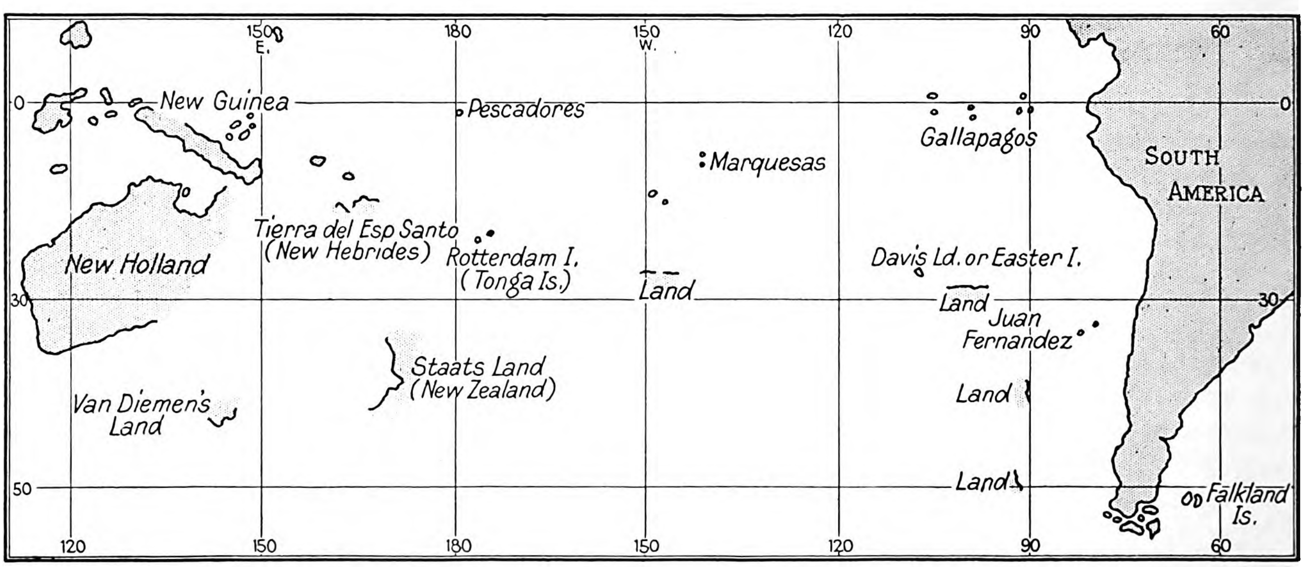
from the Straits of Magellan keeping well within the south-east trades and avoiding the westerly winds. The Magellan route was the obvious way both for South American trader and buccaneer, and the shortest way to the Pacific even if the East India Company had not held a virtual monopoly in the Cape route.

Royal Society Expedition.

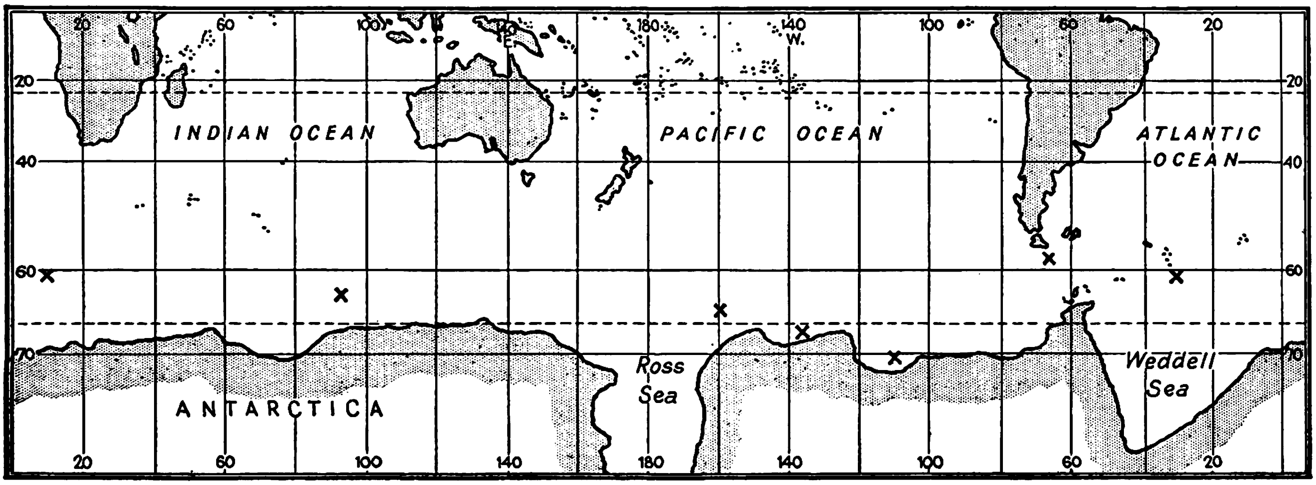
When Cook was selected by the Admiralty to take command in 1768 of an expedition to the Pacific under the auspices of the Royal Society and the patronage of King George III, he had already made his mark as a careful surveyor in Newfoundland and the Gulf of St. Lawrence. He was then a lieutenant in the Royal Navy, having gained commissioned rank after several years in the merchant service, where he worked his way from deck-hand to master. He certainly had no influence behind him except what merit had earned him, for the son of a farm-labourer who had been a draper's assistant before he ran away to sea had no wealthy and powerful friends. The *Endeavour* was to take a party to Tahiti to observe the transit of Venus, and then turn southwards on a voyage of exploration. The results of this voyage were enough to establish Cook's reputation for all time. Tasman's Staten Land (or New Zealand) was proved to be an island group and to have no relation to a continent. Cook sailed round both the north and south islands and made an admirable chart of the coasts. Few stretches of coast were left blank in his 1,800 miles of survey, which occupied him six months, and with his usual truthfulness and lack of any boastful spirit, Cook noted " such places as are drawn with sufficient accuracy to be depended upon and such as are not."

Cook was then anxious to stand southward and make Cape Horn in a high latitude in order to settle the problem of a Southern Continent. But the state of his ship did not allow this and so he sailed east for New Holland, and was thus led to the achievement that among his many discoveries has had the greatest material result to his countrymen. From the neighbourhood of Cape Howe he sailed northward to Cape York, filling in the entire missing east coast of Australia, the one important coast that the earlier discoverers of New Holland had overlooked.

Two thousand miles in four months was no mean feat, and though it was done from a moving ship the completeness and accuracy of his charting were remarkable. The *Endeavour* carried no chronometer ; the longitudes were found by lunar observations by Charles Green, the astronomer of the expedition. Cook gave this coast the name of New South Wales, though in one of the three copies of his log of the voyage the name New Wales is used. Before Cook's day Australia, known only from its less attractive coasts, was regarded as a worthless land. Cook's discovery of the well-watered east coast, though his account of the country was based on only four landings, led eventually to the colonization of Australia and incidentally to its passing to the British Crown. Then, after confirming the separation of New Guinea and Australia, for Torres' discovery of his strait was not appreciated at that time, Cook returned home *via*



SKETCH OF DALRYMPLE'S CHART OF THE SOUTHERN PACIFIC, 1764.
Showing the indications of land in the south (modern names added).



CAPTAIN COOK'S SEARCH FOR THE SOUTHERN CONTINENT

The crosses mark the furthest points to the south reached by Cook in his search for the Southern Continent. The outline of the continent is approximate.

the Cape of Good Hope. This was only the twentieth occasion on which the world had been circumnavigated, so that even from that standpoint the voyage was notable.

In his journal of this voyage Cook gave his views on the problem of a southern continent. His discovery of the insularity of New Zealand had curtailed its possible extent. From his own evidence, and his reading of that of Quiros and Roggeveen, he believed that no great land reached north of latitude 40°S. in the Pacific, but "what may lie to the southward of that latitude I know not." He thought it a pity "that this thing, which at times has been the Object of many Ages and Nations should not now be wholy clear'd up: which might very easily be done in one Voyage without either much trouble or danger or fear of Miscarrying, as the Navigator would know where to go to look for it." This was the main object of his second voyage when with the rank of Commander he sailed in 1772 with the *Resolution* and *Adventure*, two north-country colliers built like the *Endeavour* at Whitby. His orders were to "discover the Southern Continent or to disprove its existence"; if he found it, to explore as much as possible, "to make observations useful to commerce or the promotion of natural knowledge," and if he found inhabitants "to show them every kind of civility and regard."

The First Antarctic Voyage.

The voyage of the *Resolution* and *Adventure* (1772-1775) was the first and in some ways the greatest Antarctic expedition that ever sailed. A great part of Cook's course was in the stormiest seas in the world, where drifting ice and poor visibility add to the dangers encountered by a small sailing ship. And yet in the range of his journeys and the persistent efforts to penetrate the pack-ice Cook has never been equalled. For his longitudes he again depended mainly on lunars, although the expedition carried four chronometers. Several determined attempts were made to push southward in widely different longitudes and the globe was circumnavigated in a high latitude. No Antarctic land was sighted, for by singular ill-chance Cook chose for his southern ventures places where subsequent knowledge has shown the pack-ice to be persistent. Several minor discoveries were made: the South Sandwich group, South Georgia (though this island may have been known previously), and New Caledonia. Cape Circumcision (Bouvet Island), which he failed to find by searching too far to the east, Cook proved could be only an island, and he explored Quiros' boasted discovery of Tierra del Espiritu Santo and partly surveyed what turned out to be only an insignificant island group (New Hebrides).

"Had we found out a continent there," he wrote, "we might have been better enabled to gratify curiosity; but we hope our not having found it, after all our persevering searches, will leave less room for future speculations about unknown worlds waiting to be explored." At the same time he believed that there probably was land to the south of his track, though he committed his one great error in judgment when he wrote: "Should anyone possess the resolution and the fortitude to elucidate this point by pushing yet further south than I have done, I shall not envy him the fame of his discovery, but I make bold to declare that the world will derive no benefit from it."

The evidence for a southern continent in temperate latitudes was shaky, and the conception was losing

support when Cook started on this voyage. He demolished the idea. His work though negative was of the highest value. In fact, so thoroughly did he establish a disproof in the conception of this elusive continent that it was a slow and arduous task to recreate belief in a great southern land mass when in the nineteenth century confirmatory evidence came to hand. A generation or more passed before any serious attempt was made to penetrate Antarctic seas, and even when land was discovered in the far south in the third decade of last century it drew little attention. It was not until 1886 when Sir John Murray, arguing from scanty circumstantial evidence, revived the conception of a great continent, and with his habitual sound judgment drew an outline of its shape that subsequent exploration has little modified.

The Last Achievement.

In his third voyage in 1776 Cook solved some further problems in the Pacific and added to his many discoveries, but his attempt to find a north-west or a north-east passage—the main objects of the voyage—was a failure. So desirable did such a passage seem to be for the commerce of Britain that in 1745 Parliament had offered a reward of £20,000 to the discoverer of a north-east passage. Before Cook sailed the reward was extended to include the discovery of any passage between Atlantic and Pacific north of latitude 52°N. Cook's explorations with the *Resolution* and *Discovery* were extensive. As usual he charted many coasts and added new features to the map. Tracing the coast of North America northward from Vancouver Island he thought he had found the north-west passage in Cook Inlet, and eventually, after passing Bering Strait, reached Icy Cape in the Arctic Sea before pack-ice forced him to turn. On the Asiatic side he had no better luck, but it was characteristic of Cook that the failure to the east and the danger of ice did not deter him from attempting to find a road by the west. This was Cook's last great feat of exploration. He intended to return to the quest the following summer, but was slain at the Sandwich Islands in February, 1779. His successor in command, Captain Clarke, imbued with Cook's high determination, endeavoured fruitlessly to better Cook's record.

Much of Cook's success was due to his perseverance, his fine seamanship, and his qualities as a leader. But it must be remembered that in his day the great difficulty in any long cruise was the likelihood, even the certainty, of loss of strength and life through the disease of scurvy. Every vessel that was at sea a few months suffered from it. No preventive or cure were known. Anti-scorbatics of doubtful efficacy of which the chief was sweet-wort made of malt were used. Cook realized that scurvy was the great enemy he had to face, and he fought it with every means his experience could suggest. Some of his measures were of value; others were probably useless as preventives. He supplemented the issue of wort with sour krout, mustard, vinegar, broth, orange and lemon juices and vegetables. And best of all, he missed no opportunity of gathering wild celery, scurvy grass, and other herbs. Perhaps the cleanliness on which he insisted in the fo'c'sle, an innovation in ships of that time, did not combat scurvy, but must have added to the health and comfort of his men. At any rate, his efforts were successful. Scurvy was rare, and death from the disease unknown on his ships. The crews maintained their health in a way that was considered marvellous in those days. This was the secret of his long voyages, the time he was able to spend at sea and the relative short stays in port he required to recruit the health of his men. The mastery of scurvy, or at least the ability to keep its ravages in abeyance, was not the least of Cook's triumphs, though the explanation of his preventive measures was not found till a later date.

There are no descendants of Captain Cook. Only one of his six children reached maturity and he died unmarried. Captain Cook's wife died at the age of ninety-three, and was buried in the Church of St. Andrew the Great, Cambridge, where a memorial tablet to Cook and his family was erected.

New Value from Gas Wastes.

In the course of a new inquiry at the organic chemical laboratory of the United States Bureau of Mines, Washington, into the cause of gas-meter stoppages, it was found that the main cause of the trouble was gum formation from indene and styrene. These compounds are always present in manufactured gas. In freshly made gas they are very volatile and readily carried in the gas stream, but on standing in contact with other gas constituents they tend to "polymerize" or form gums.

A recent survey of the American gas industry shows that there are eight million pounds per year of styrene and twice that amount of indene available if completely removed from the gas. These compounds could be used in the manufacture of plastics, and styrene used for perfumes and possibly in rubber manufacture. It is suggested that here is a field for the development of substances which are now admittedly industrial nuisances.

American Views on Rocket Flying.

In July DISCOVERY *published Herr Max Valier's second article on experiments in rocket flying. Since that date the " Scientific American " (August) and " Science and Invention " (September) have each published similar articles, which indicate the wide attention attracted by the German inventor's proposals.*

As one of the pioneers in rocket-flying investigations is an American—Professor Robert Goddard, of Clark University—it is to be expected that the scientific Press in the United States are following eagerly the new German experiments of Herr Max Valier. A first practical proof of the power of rockets was given by the recent rocket-car test, described in *Discovery* by this inventor, who added some remarks on proposed flying developments. The new information briefly supplemented the detailed plans published in our columns a year ago, and its only serious significance was to show that Herr Valier is still pursuing a fascinating problem. That the scheme is impractical with present devices *Discovery* made no attempt to disguise, a fact which is emphasized by a highly speculative article in *Science and Invention*, edited by Mr. Gernsback. Yet as the title page of this American magazine appropriately affirms, Huxley once stated that " those who refuse to go beyond fact rarely get as far as fact." Rocket flying—like the early attempts at our present aviation—certainly needs imaginative thought if its difficulties are ever to be solved.

The Fuel Problem.

One branch of this research which already lends itself to practical experiment is the problem of fuel, and on this some comment is made by Mr. Gernsback. " As is well known," he writes, " the usual rocket uses a mixture of black powder and other chemicals, and the reaction during firing lifts the rocket up into the air. As soon as the powder has burned itself out, the rocket comes down to earth, so the problem, from the engineering standpoint, is to have enough rockets to explode or enough fuel constantly fed to one rocket to keep the machine, whether automobile, airplane or space flyer, going indefinitely.

"Years ago, I conceived the idea of a dynamite motor, the idea being to explode small charges of dynamite in a cylinder by feeding cartridges on a belt through a special device. The ensuing gases were then expelled to propel the machine. Unfortunately, the crude experiment soon came to a close, because the engine blew up; fortunately, without hurting myself and my co-experimenters. But I see no reason why, with proper safeguards, such a propellant could not be used, working on the rocket principle.

Dynamite.

" Dynamite is a fairly safe substance to handle, if it is used in the correct manner, and its propellant force, as compared with black powder, is inordinately greater. This is because the amount of gas liberated by dynamite is three times that of black powder, such as is used in rockets. There may, of course, be found other fuels that can be used for rocket propulsion, because there are many more powerful explosives than dynamite known to science to-day. The idea of using such powerful explosives may at first appear fantastic, but no more fantastic than exploding gasoline and air mixture in the present day motor-car. The difference between the explosive force of gasoline and air mixture and nitroglycerine, for instance, is only a matter of degree and speed of concussion. It all comes down to handling the fuel in a safe manner. While vastly inferior to dynamite as an explosive basis, gasoline is used to-day only because its liquid form gives a comparatively simple way of handling, which is not the case with dynamite, and liquid nitroglycerine would be too dangerous."

On the other hand, Professor Goddard himself is far less guarded in a prefatory statement to an article in the *Scientific American*: " If atomic energy were available, it would be a very convenient means of propelling an interplanetary rocket. Atomic energy is not, however, necessary, as an interplanetary flight is possible with means even now at our disposal. This is set forth in my article in the Smithsonian Miscellaneous Collections for 1919. If a propellant of high energy content, such as hydrogen together with oxygen, is used with high efficiency and in the proper way, an interplanetary flight is possible in a rocket that is neither tremendously bulky nor unwieldy. A rocket using a low energy propellant, and operating inefficiently, would, on the other hand, be impracticably large. The technique of such a flight constitutes a most interesting problem in physics, and is one to which I have given considerable thought for many years. In the light of the conclusions I have reached, I can say that, although Mr. James

R. Randolph's article, 'Can We Go to Mars,' may read like romance, it is nevertheless thoroughly scientific, and, while not telling the whole story, it gives a good picture of what an interplanetary rocket must be like."

A Peep at Mars.

In publishing the article referred to, Mr. O. D. Munn, the editor of the *Scientific American*, "makes no apology," and he explains that the plan is theoretically sound: "It is not a Jules Verne story nor an H. G. Wells story, nor even one of Dr. Hacksaw's secrets. It is a physicist's conception of a method for getting close enough to Mars to see what Mars is really like. The article was first submitted to several laymen for opinion. They voted against it. It was then sent to several physicists. These favoured publication. In itself this may have some significance. Mr. Randolph's plan cannot, of course, be realized at present; he says so himself." As, however, it gives a new approach to the problem and the machine described closely resembles Herr Valier's own rocket ship, the plan is of particular interest.

Briefly, instead of "shooting" at the moon, an attempt would be made to reach Mars, which in Mr. Randolph's opinion presents the most interesting possibilities. "The space between the two planets is devoid of air, or any other kind of matter," he writes. "Hence, there is only one way in which such a trip could be made. A projectile of some sort would have to be thrown off from the earth with sufficient velocity to clear the earth's attraction, and would then have to be directed into an orbit that would touch the orbit of Mars at the time Mars got to that particular part of it. Then, its velocity would have to be reduced so that it could be captured by the planet and become a satellite. Such it would remain for about a year, at the end of which time its speed would have to be increased, returning it to its own orbit, and thence back to the earth.

"Thus the projectile would have to be able to change its velocity in a vacuum, and at the start it would have to attain a velocity of seven miles per second, as that is the velocity needed to escape the earth's attraction. There is only one device known to science at the present time with which these requirements could be met. That is the high-altitude rocket invented by Professor Goddard. . . . Engineering difficulties may be looked for because of the enormous size of the machine, and the cost will be very great, but the plan is by no means impossible."

To design a small-scale apparatus is, of course, quite an easy matter compared with the conditions involved by one large enough to be capable of leaving the earth and of carrying men. By way of illustrating this difficulty, Mr. Randolph writes: "A brick pier a few feet high would support a weight of 4,000 pounds for each square inch of its surface. But a pier a mile high weighs more than 4,000 pounds per square inch of horizontal section. Hence it would break of its own weight, unless spread out like a mountain to give a broader base. Five miles of steel wire form a heavier weight than the wire itself can support. And as these limiting weights are approached, the proportion of structure to useful load increases, and the skill required in design becomes greater, in order to keep this proportion down.

"In a rocket, all loads would be greatly increased by the rapid acceleration at the start, but this could be calculated in advance and allowed for. Acceleration in a rocket like this is under perfect control. The numerous small charges are fired by a time clock, and at any rate desired. Even in the simpler rockets, like Goddard's present forms, there are ways of controlling this, as by making the grains of the powder small or large. The smaller the grains the faster the powder burns. But in an actual trip the acceleration should be made just as great as the passengers could stand. This would be tried out beforehand, possibly in a rapidly revolving drum, and the start of the rocket governed accordingly."

Two Years Journey!

After describing in some detail a proposed rocket machine, Mr. Randolph reverts to the problem of its flight. "This rocket," he proceeds, "when clear of the earth, would be given an added velocity of about two miles per second in the direction in which the earth is moving with a velocity of 18.5 miles per second. This would throw it into a much more elliptical orbit, which would bring it to the orbit of Mars about seven months later. Departure would be so timed that Mars would be there when it arrived. It would then be slowed down until it became a satellite of Mars, which it would remain for about a year. Then, the positions of the planets being suitable, it would be speeded up and brought back to earth. A large and heavy mass like this, approaching the earth at seven miles per second, could not be safely landed. Hence it would be abandoned when near the air, and the occupants would come down in the landing plane [specially carried for the purpose in the rocket]. This is a small air-tight glider, with folding wings, and having a special door to permit its release.

"A rocket such as this would weigh as much as an ocean liner, but would probably be easier to design, as the structure is more compact and the forces more definitely known. But its accommodations would be severely limited, as food, water, and even oxygen for the entire journey of over two years would have to be taken along."

To English readers, notwithstanding the maxim from Huxley earlier quoted, there is something curiously naïve in the solemnity with which Mr. Randolph next remarks that, "because of its high cost, and the lack of a financial motive for the trip, it is likely to be a long time before such large rockets are built."

Exploring the Atmosphere.

It is interesting to learn, in conclusion, that the Goddard rocket in its present size has now reached the stage when it could be used for exploring the upper atmosphere, beyond the range of sounding balloons. The next development that is planned is the study of the Heaviside layer, which exists at an altitude of about sixty miles above the earth's surface, and is believed to play an important part in the transmission of radio signals. It is also hoped to take astronomical photographs from outside the earth's atmosphere. Eventually, for the larger experiment, a preliminary method proposed is the projection of a small mass of magnesium powder to the moon.

A similar French scheme to use rockets for upper air exploration, as reported in *Nature*, was the subject of a lecture before the Société Astronomique de France, the president of which, General Ferrié, contributes a commendatory preface to the printed report. The subject has been studied by the author, M. Esnault-Pelterie, for twenty years, as well as independently investigated more recently by Oberth and Hohmann, besides, of course, Valier and Goddard. In a discussion of experiments on the propelling power of various explosives, M. Esnault-Pelterie considers the conditions of ejection, both neglecting and taking into account the resistance offered by the earth's atmosphere. Like Professor Goddard, he concludes that it is already practicable to send exploratory apparatus of small mass to heights of some hundreds of kilometres; but that it is not at present practicable to eject enclosures large enough to contain human beings, with all the necessaries for their existence on a journey outside the earth's region of attraction, together with a sufficient supply of the propellant explosive to ensure their safe return.

Whether the French will beat the Americans in exploring the upper atmosphere remains to be seen.

Correspondence.

AMAZON NATURAL HISTORY.

To the Editor of DISCOVERY.

SIR,

In your August issue, page 264, are some interesting photographs of wild life from the Amazon Valley. Figure 2 is that of "a brilliant bird of the Cormorant family." The common name of this bird is Darter, or snake bird, belonging to the family Plotidae of the order Pelecaniformes. It is also called snake-neck from the habit it has of swimming with the body submerged and only the neck exposed above the water, so it really looks not unlike a snake coming along.

Figure 4 is described as "a raccoon taken at Para." It is a member of the same group as the raccoons, but has a longer snout, the skull is relatively longer and narrower; it is the Coatimundi. There are two species, the white-nosed coati (*Nasua nasica*) which inhabits Mexico and Central America, and the red coati (*Nasua rufa*), inhabiting South America from Surinam to Paraguay. These animals are mainly arboreal, their food includes fruits, young birds, eggs, lizards, and insects.

The other figures in the plate of photographs from the Amazon Valley are also interesting, but these are more fully described. *Discovery* is of particular interest this month to the naturalist.

Yours faithfully,

J. W. CUTMORE,
Late Keeper of Zoology to the Liverpool Free Public Museum.

65 Derby Lane, Liverpool.

A FOREIGN SUBSCRIPTION LIBRARY?

To the Editor of DISCOVERY.

SIR,

I should be very grateful if you could inform me whether any library exists from which, for a moderate subscription, modern foreign zoological works, German ones in particular, could be borrowed. I frequently wish to find out the most recent work done abroad in the various branches of this subject, but have been unable to get sufficiently modern and advanced books or papers. I have applied, among others, at the London University General Library, and the Central Lending Library for Students, and also at the Science Library. The officials at the Natural History Museum are always most kind and ready to assist, but one hesitates to apply there as often as is necessary, because that library has no accommodation for general readers, and is, I believe, not intended to be used in that way. Further, it is not a lending library. It appears that the British Museum at Bloomsbury has such works as I require, but, of course, for reference only. The library of the Zoological Society is open only to Fellows of the Society, and the entrance fee and the subscription, which amount to eight guineas, is more than many ordinary students can afford.

I have been greatly assisted by the articles published in your paper from time to time on the work done abroad, by von Frisch and others, but, of course, these are not sufficiently detailed. I hesitate to trouble you in this matter, but perhaps others among your readers have met with similar difficulties.

Yours truly,

LONDON STUDENT.

[At short notice since this letter was received, we have been unable to trace our correspondent's requirement. As this is of general interest, information will be welcomed.—ED.].

Promoting Growth by Ultra-Violet Light.

By L. V. Dodds.

Ultra-violet light is being successfully applied to animals and plants by the London Zoological Society and the Royal Botanic Society. This interesting work supplements the medical and industrial applications.

CONSEQUENT upon recent developments in the therapeutic uses of sunlight and the remarkably beneficial results obtained, those engaged in light research have given considerable attention to promoting the growth and increasing the vitality of plants and animals by the aid of ultra-violet light. Many experiments have been made, and from the data now available it is recognized with certainty that this field offers enormous scope and is one in which the commercial developments may well prove of national importance.

Two Methods.

Two methods are being used for this work, one using natural sunlight to the maximum capacity and the other employing rays generated artificially. Obviously the chief difference between the two is that whereas the former can be used for comparatively large areas, the latter method is entirely localized. Furthermore, the expense of sunlight lamps limits their use for some time to come. It is customary to decry our British climate, but a study of the official meteorological records will show that actually the country receives a considerable amount of sunlight. The trouble, therefore, is not so much with the supply as with the way in which the light is used. Smoke pollution of the atmosphere effectively prevents a large proportion of the ultra-violet rays from the sun ever reaching the earth at all, and the widespread use of glass which cannot transmit these rays effectively screens the remainder from all buildings and enclosures not fully exposed.

Schemes for smoke abatement are improving the atmosphere, and the invention of a true glass which will transmit as much as eighty per cent of these rays essential to health has resulted in many extraordinarily successful developments. Mr. F. E. Lamplough first produced a glass of this type, and his invention is now being marketed extensively under the name "Vitaglass." This material is a true glass and is designed to replace ordinary glass in all its uses, but other materials capable of transmitting a high percentage of ultra-violet light are now available, and many of them are especially designed for use in farm buildings, greenhouses, solaria and the like, where actual visibility is not so essential as in private homes and hospitals. The most usual types of materials intended for such uses are made of a cellulose acetate compound, often reinforced with a fine wire mesh of galvanized wire. There are naturally variations in each product, but the results, while not admitting so much visible light as ordinary and special glass, are eminently suitable for use in agriculture, horticulture, and stock-keeping. These materials can be made at less expense than a true glass, and they are being used extensively by practical farmers.

The experiments of the Royal Zoological Society of London have aroused widespread interest. At the well-known gardens in Regent's Park, the monkey house, the lion house, and the new reptile house, have each been roofed with Vitaglass, while for special purposes tungsten lamps have also been used. Reporting on the work Dr. P. Chalmers Mitchell, Secretary to the Society, states that the use of the glass and of ultra-violet light from electric bulbs "seems to have notably improved the general health and vitality of the apes and monkeys and the carnivora to which it has been applied."

In the Farmyard.

The installation of this special glass has followed in many racing stables, cowsheds, and training establishments in this country, as well as on the continent and in America. Many experiments on the irradiation of pregnant cows and pigs have been made by workers in Germany, and the results show that it is even possible to compensate for a diet deficient in vitamin by using ultra-violet light, and such methods have been adopted recently on a Surrey farm with very satisfactory results. The new greyhound kennels at Denham, Bucks., said to be the finest in the country, are the latest addition, while the King's filly, "Scuttle," winner of the Two Thousand Guineas, is one of several well-known race-horses which regularly receive general irradiation from ultra-violet lamps in order to maintain health at the highest standard.

One outstanding feature of the Zoological Society's work is that it has been shown very clearly that while

natural sunlight used to its maximum extent by the new glass is almost always beneficial, the exposure of animals to tungsten lamps may be attended with serious consequences. A very short exposure caused the death of several reptiles, while a shorter treatment than would be given to a human being was applied to a rickety young elephant and the animal was badly burned. Several birds, too, died from excess of sunlight supplied by this means. It would appear that the artificially generated rays are too powerful in many instances, and certainly further experiments must be made on the vexed question of essential dosage before these lamps can be used on the farm with safety.

Another indication of the varied ways in which these researches are being conducted is given by the work of two French scientists, M. Phisalix and M. Pasteur, who have made experiments intended to discover whether ultra-violet rays would destroy the venom of snake poison. It was found, however, that the rays destroyed all the elements in the venom that were not dangerous, but left the virulence of the poison untouched.

Animals are protected by a thick covering of hair which it is not always possible to remove, and in treatment with ultra-violet light artificially produced there is a great hindrance to the penetration of the rays. By continually rubbing up this hair while the exposure is being made, penetration is assisted considerably but the length of the exposure must be increased. The hair is less dense under the thighs, and treatment so directed may be more effective. To give the animal a good wash is also of considerable help, as for protective purposes animals have been provided with a much thicker skin than man and they

ULTRA-VIOLET TREATMENT FOR GREYHOUNDS.

This application of light is found to be beneficial to the dogs, which are now frequently treated in this London laboratory.

SUNSHINE AT THE ZOO.

The inventor of Vitaglass, Mr. F. E. Lamplough, is here seen in the lion house at the London Zoo, where this special glass has been installed.

do not wash as frequently. Because of this, a thick layer of epithelium and grease is formed, which acts as a waterproof covering and also as a dense screen to the rays. There is a great variation in these points between different breeds of animals and every patient of each breed, so that each case must be considered separately when determining the exposure. Apart from general tonic treatment, alopecia, ecylma and rickets respond readily to irradiations, while it is also useful in pneumonia, catarrhal fevers, and to some extent in chorea.

The new glasses have been used with much success in greenhouses, and writing of one of these materials Professor Leonard Hill, of the Medical Research Board, states: "It is possible that the results of experiments with 'Windolite' on growth of plants and their anti-rachtic and growth vitamin qualities may profoundly alter greenhouse practice. Enough has already been done to show that growth and fruiting are altered by giving or withholding ultra-violet rays. It has also been shown that the successful raising of chickens, and the laying power of hens and the fertility of eggs, are increased by ultra-violet radiation."

In tests made at Kew it has been established that seeds grown under Vitaglass germinated twenty-four hours before those grown under ordinary glass, and after three weeks the plants are sturdier and of a deeper green. Tomatoes which receive the maximum amount of rays by this means ripen in advance of those grown in the usual manner, while lettuces were stronger, with bigger hearts, and of a richer shade of green. By adopting the use of a glass of this type it would seem that the British market gardeners would be able to compete successfully against foreign growers by hastening forward their plants and selling them before the market is glutted by continental produce. In several instances similar tests are being made and

each reports satisfactory progress. Messrs. Toogood and Sons, the Southampton seedsmen, are carrying out several experiments under the glass on small seedlings, both flower and vegetable, to study the effect on "damping off." They are following actual rapidity of growth with a perennial rye grass test. Westfield College, London, are raising various kinds of seeds for South Africa, and the head gardener reports that under the new glass bedding plants are blooming much earlier. A third test has been begun by the authorities at Kew, in which a greenhouse is used fitted with four different kinds of glass in sections, ordinary glass, both clear and opaque, and similarly special glass. The same plants will be grown under each type of glass during the summer.

Experiments on Plants.

Not all plants are amenable to treatment with ultra-violet light. An experiment at Manchester with the seed hips of roses produced no apparent effect whatever, though the leaves of the plant showed marked development. This test, however, must not be accepted as conclusive for the dosage may have been at fault. Further work of similar kind has been done at the gardens of the Royal Botanic Society, London, and, as reported in a recent issue of *The Times*, these are of especial interest to owners of conservatories and aquaria. These experiments were designed to show particularly the development of plant growth aided by the sun's ultra-violet rays. The curator of the gardens, Mr. J. L. North, states that two bowls of equal size filled with water were used, and in each one was placed thirty plants of Lemna Minor, the Lesser Duckweed which is so common on ponds throughout the country. One bowl was covered with Vitaglass and the other with ordinary glass of the same size and thickness, and the two were placed together outside the Museum, in such a position that no sunlight could reach them until after mid-day. To admit air and decrease condensation the glass was tilted slightly on one side. After twenty days the two bowls were examined, and in the one covered specially fifty-four plants were found while in the other there were only forty-one, thus proving that by the aid of ultra-violet rays propagation had been more than doubled.

These tests are admittedly tentative experiments only, yet the satisfactory results obtained with a plant like Lemna, which is a very primitive growth requiring no soil for its subsistence, indicate to some extent the developments which may be expected with a plant of more advanced type that has a greater amount of foliage to absorb the sun's rays. Recent demonstrations in greenhouses support this theory and, as this knowledge becomes more widely known, the results will be of corresponding importance from both a scientific and economic standpoint.

Research is also being made into the possibilities of accelerating plant growth by the use of ultra-violet rays from lamps. As with animals, ascertaining the correct dosage is one of the chief difficulties, and so far, except in special instances on which it is unwise to base an opinion, the results of such experiments have not been so satisfactory, and some considerable time will elapse before quartz lamps are used in the garden to any great extent. To indicate the scope of the work, however, in America the Wisconsin Agricultural College claim that grain and sugar cane can be made to mature more quickly under ultra-violet light.

Poultry farmers have already benefited considerably by the new glasses, and very careful tests have been made with the object of their commercial application in this way on an even more widespread scale. One of the greatest difficulties with which the poultry keeper has to content is leg weakness in chickens, and it is a common source of loss. Research has shown that when Vitaglass is used in the brooder, leg weakness does not occur and, moreover, the chicks do not suffer from many of the other ailments to which they are subject. The growth of the chickens is also affected beneficially, and it is claimed that they are in lay very much earlier than those reared under ordinary glass. The value of this means is specially useful in the case of winter and autumn chickens when the weather will not permit the use of an exposed run, and in this way also it may be possible for poultry keepers in England to contend more successfully against foreign importers.

Future Developments.

The importance of ultra-violet light, both from the sun and produced by artificial means, in relation to plant and animal growth, is very considerable, and scientists both in Europe and America are concentrating on the further development of a discovery which will entail far reaching results. Professor Hill says that the use of a suitable window glass "may profoundly alter greenhouse practice," but in the future, the advanced application of ultra-violet radiations may largely necessitate the reorganization of our present agricultural and horticultural methods, while the effect on stock-keeping will be correspondingly remarkable.

Thus this research is now extending its scope from industry and medicine to modern farming practice.

Canada Saves the Big Horn Sheep.

By Dan McCowan.

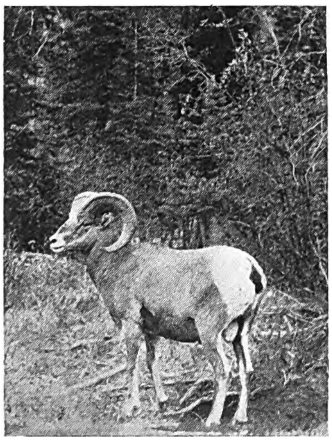
In our July issue Mr. H. J. Massingham described the present rapid destruction of mammalian life throughout the world. By contrast a Canadian contributor sends us an account of how the Big Horn sheep has been saved from extinction in the Rocky Mountains, where it once more flourishes in large numbers.

At the opening of this century all the wild sheep on the eastern slope of the Canadian Rockies could have been accommodated in an ordinary railway truck such as is used in the transportation of domestic stock. To-day, in the mountainous region round Banff and Lake Louise alone, enormous numbers of Big Horn sheep are to be seen, and it has been estimated that in Banff National Park at present there is a wild sheep population of over twenty thousand. This condition, so pleasing to record, has been brought about as a result of conservation measures taken by the Dominion Government at a time when it seemed as if this fine animal would become extinct.

The " Big Horn " is a bold mountaineer, stocky in build, surprisingly agile, and altogether well adapted to live on the high plateaus. Indeed, it would almost appear that he has become inspired by the strength and dignity of his lofty environment. Always he seems clean and fresh as the flowers that bloom on his native meadows, and he walks with a proud step on the highlands on North America.

A full grown ram stands about thirty inches high at the shoulder, and when in prime condition weighs from two hundred to two hundred and fifty pounds. Ewes are considerably smaller and lighter than rams. Both males and females are furnished with horns, the ram horns being very massive and gracefully curved. Those on the ewes are short, flat, and but slightly curved. Unlike the members of the deer family, sheep do not shed their horns annually, and so, from prominent wrinkles in the horn—each one marking a birthday—one may not only ascertain the age of the animal, but also how it has fared on the journey through life. Years of plenty and years of famine are there indelibly etched. On old rams the horns are badly stubbed and frayed through contact with rock and stones, and as a result of the strenuous fights which take place annually amongst rivals for possession of bands of ewes. It is interesting to note that while females of the species seldom venture far from the valley or hillside where they were born, rams are notoriously roving in disposition, travelling long distances in a very short time and ranging over a wide territory. In this way nature guards against the danger of inbreeding.

Lambs come towards the middle of May or early in June. Twins are common, but triplets are seldom seen. Like their domestic cousins these young sheep are playful creatures, loving to scamper and frolic amongst the crags and across the upland meadows. Even when but a few days' old they seem surprisingly agile and altogether fearless, ascending and descending precipitous places without the least hesitation. The surefootedness of the white goat of the Rockies has for long been proverbial, but even he does not " watch his step " half as well as the mountain sheep when scrambling amongst the cliffs and crags of home. The goat, in all his movements, is deliberate and


IN THE ROCKY MOUNTAINS: A FULL-GROWN RAM (CENTRE), WITH GROUPS OF YOUNG SHEEP

cautious, the Big Horn, by comparison, seems reckless and foolhardy. At times a false step would result in death to the daring animal, yet seldom is there fatality or even injury from such cause. Indeed, this impetuous creature depends on daring and dash when striving to elude that giant weasel, the wolverine, to outstrip the pursuing wolf, to avoid the claws and teeth of the cougar, and to escape the whirling sweeping avalanche that thunders into the valley.

The wild sheep of the Canadian Rockies are singularly free from disease ; in fact, there is no record of an outbreak occurring amongst these animals in their native haunts. During April and May they are sorely infested by ticks which, although doubtless a source of great annoyance, do not seriously impair the health of their hosts. The natural term of life granted to these sheep is from fifteen to eighteen years. When old age dims the eye and stiffens joints and muscles, when the thin air of high altitudes scarce serves to fill the lungs, the weakening animal descends into a quiet valley and there, in some secluded nook amongst the friendly trees, goes peacefully to the last sleep of all.

Much pleasure may be derived in watching and studying Big Horns in their native habitat. Striving to obtain photographic trophies of a group of rams or a small flock of ewes and lambs, one is lured upwards from the verdant pasture places on lower slopes to the great ramparts where trees scarcely find a rooting. Then on and on, climbing higher and yet higher amongst limestone cliffs and through gritty shale till the clean cold region of snowfield and glacier is reached. There is a solemn grandeur in such remote and unspoiled places. The clouds seem near at hand and kindly, the everyday world is far away and forgotten. Resting in the shadow of a great rock there comes to one an infinite peace in contemplating the handiwork of Him who tends the wild sheep on a thousand hills.

Among the Stars : A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

THE giant planet Jupiter is coming into a favourable position for observation, being in Aries, some 12° to the south-east of Hamal, the chief star of that constellation. It is interesting and useful to study the ever-changing surface markings, and to note the different rates of rotation of different regions, which are determined by observing the times at which various spots cross the central meridian. The equator goes round in 9 h. 50 m., while the temperate zones take five minutes longer. The satellite phenomena are also attractive to watch ; there is an eclipse of satellite III on 2nd September, disappearance being at 1.1 a.m. (summer time) and reappearance at 3 a.m. ; both occur low left of the planet in an inverting telescope.

Uranus and Mars.

Uranus is also well placed for observation. It is in Pisces, some 3° east and 13° south of Gamma Pegasi, which is the low-left component of the " Great Square." It may be glimpsed with the naked eye, and is quite easy with good binoculars. In the telescope its disc appears greenish ; large instruments are necessary to see any markings on the disc, or to detect the satellites. Mars may be observed in the latter part of the night. It passes near Zeta Tauri (the southern horn of the Bull) on 18th September and will reach opposition, in the feet of Gemini, on 21st December, though it will be nearest to the earth on 15th December. Its high north declination is favourable for observation.

It is also worth while to note that the tiny planet Eros passed opposition on 27th August. On 5th September it is 40′ south of Theta Pegasi, and on 21st September it is 5° south of Epsilon Pegasi. Its magnitude on this occasion is only 11, but at the next opposition, in January, 1931, it will reach magnitude 7, being then within fifteen million miles of the earth. Extensive preparations are being made to observe it then, in order to obtain an improved determination of the sun's distance.

There is at present a lull in cometary observations, after a period of great activity. No observations have been reported since 24th May. Search is, however, being made for two periodic comets. The first is that discovered by the late Mr. Edwin Holmes of Islington in 1892, one of the few comets discovered in London. It was then a naked eye object, but some temporary disturbance must have caused unwonted brightness, as it was extremely faint at the two following returns in 1899 and 1906. It has not been seen since 1906, but this was owing to the death of Dr. Zwiers, who attended to its perturbations. These remained neglected till Mr. Polak, and subsequently Mr. Cripps, took up the work, and found that the comet was due at perihelion about 23rd March, 1928 ; it was then so near the sun in the sky that observation was hopeless, but it is now better placed.

The other comet is also a British one, having been found by Mr. C. Taylor at the Cape in November, 1915. It was a fairly bright object, and was observed for six months. Like Biela's comet it divided into two portions. It must have returned to perihelion in June, 1922, but escaped observation then, being badly placed. It is due at perihelion at the end of next October, and may be observed during September. It is moving nearly due east, from Gemini into Cancer.

The variable star Mira Ceti passed through maximum brightness at the end of August, and it should be an easy naked eye object throughout September. Its position is R.A. 2 h. 16 m., S.Decl. 3° 18′, and therefore it is some 17° south of Jupiter. The best way of estimating the brightness of variables is to find two neighbouring stars, one brighter than the variable, the other fainter ; we then judge that the brightness of the variable is one-third (or whatever it may be) of the way from the first to the second. Alpha Gamma, Delta, and 75 Ceti are suggested as comparison stars ; their magnitudes are 2.7, 3.5, 4.0 and 5.6 respectively. The first two are suitable when Mira is near maximum, the others later on

Book Reviews.

From Magic to Science. By CHARLES SINGER. (Ernest Benn Ltd. 25s.).

Dr. Charles Singer has a wide and well deserved reputation as an authority on the history of medicine. In the present book his scope is somewhat wider, in that general science comes prominently into the picture, and the collection of essays is arranged in such a way as to form a delightful commentary on the emergence of science. He traces its evolution from the stark utilitarianism of the Roman era, through the ecclesiasticism of the Middle Ages, and the magic philosophy of Hildegard, to the dawn of the true scientific era at the beginning of the sixteenth century. It is impossible adequately to review this book after one reading, for the pleasure to be culled from the author's profound erudition and artistic treatment of the subject is cumulative in effect. It is one of those pleasures to be reserved and slowly enjoyed in the lengthening autumn evenings.

The first essay, "Science under the Roman Empire," is above all things comprehensive. There is an undeniable flavour of practical politics about the warning given some thirty years B.C. by the Roman writer Marcus Terentius Varro, not to build houses in the neighbourhood of marshy places. "Because when the marshes begin to dry they engender a multitude of invisible insects which are introduced into the mouth and nostrils with the inhaled air and occasion serious illnesses." It is to be hoped that the General Medical Council have placed a portrait of Julius Caesar in an honourable position, for it was he who conferred such exalted social status on the medical practitioner when he raised him from serfdom to the rank of a Roman citizen. It is to the practical policy of the Romans that we owe the hospital system. Dr. Singer describes the first hospital which was established on an island in the Tiber about A.D. 41-45. There is an amusing sketch of an instrument used by the Romans to measure distances along a road—surely it was the first ancestor of the modern taxicab? The Roman attitude to science and the manner in which natural phenomena were rendered subservient to the needs of the Empire are described by the author with the authority conferred by long familiarity with the subject.

The next essay deals with the mysticism of the Middle Ages. The words of the author himself best illustrate his method of dealing with this chaotic period. "It is beside the point to urge that the Middle Ages contributed little to the actual sum of knowledge of the external world. What we want to know is *why* they contributed so little." It is not necessary to remind the reader of the wealth of material which is included in the period of the Middle Ages; the truly supernatural genius of Copernicus, Kepler, and the painstaking observations of Tycho Brahe formed, from a universal morass of dubious philosophy, that firm basis of fact upon which the whole edifice of modern science now rests. In his treatment of this period it is difficult to think of any point of view which the author has omitted; but his detached standpoint is so well maintained that the reader may congratulate himself on the true perspective which is presented concerning this somewhat confusing period in scientific history.

Space does not permit me to describe in detail the subject matter of the remaining essays, but the author's reputation will be sufficient to recommend them. It is perfectly obvious that no expense has been spared in the production of this book. Its price is twenty-five shillings, and it is ridiculously cheap. There are fourteen exquisite plates in colour, including some charming pictures of plants taken from mediaeval Herbals. There are also some delightful reproductions from the Hildegard manuscripts. There are one hundred and eight line drawings and diagrams, and a title page taken from a French manuscript of the sixteenth century. The title is truly descriptive, and, as I have already said, it is a painstaking work of great learning. It should not only be of interest and value to students of science and history, but it should also afford pleasure to artists and others who are in search of beauty.

V. E. PULLIN.

Skyward. By COMMANDER RICHARD E. BYRD, U.S. Navy. (G. P. Putnam's Sons. 15s.).

The Art of Flying. By CAPTAIN NORMAN MACMILLAN, M.C., A.F.C. (Duckworth. 5s.).

An Approach to Winged Flight. By JOHN D. BATTEN, M.A., LL.B. (Dolphin Press. 5s.).

Now that the non-stop flight across the Atlantic has been attempted both successfully and unsuccessfully so many times in the past year or so, we are apt to forget, amidst the glamour of the American successes, that this feat was first accomplished by the British airmen Alcock and Brown as far back as June, 1919. Commander Byrd pays great tribute to the courage of these two pioneers in attempting the flight with the unreliable aircraft engines of those days. He makes out a clear case for the three-engined plane as an important factor in such flights, and attempts to show that, provided due precautions are taken, these spectacular flights are more than the mere stunts which they appear to the public to be. A spectacular flight, the author urges, acts as an impetus to the development of aviation by arousing public interest. But are not the equally spectacular achievements of Sir Alan Cobham and Bert Hinkler infinitely more valuable in establishing future aerial routes, with nothing like the same unnecessary risk attached to them? Byrd shows clearly the great danger of taking-off with the heavy load of petrol necessary for a three-thousand mile flight, and his own descent into the sea forced by the weather conditions makes it obvious that there is an enormous element of luck, besides exceptional piloting and navigating skill, required for making a successful trans-Atlantic flight. The story of Byrd's polar flight of 1926 describes the part played by aircraft in the conquest of the Arctic. This expedition, like that of Amundsen a year previously, was well prepared for a forced landing in case of engine trouble, but he was more fortunate than the Norwegian in this respect.

An interesting description of the expedition to the South Pole which Commander Byrd is attempting this coming winter, together with an insight into the great amount of preparation which goes on "behind the scenes," before the start of an exploring venture, concludes this book. Whether the results obtained by the dozen scientists, coupled with the desire for adventure and the achievement of having reached both Poles, will justify the trouble, risk, and expense entailed, remains to be seen. At any rate, it is to be hoped that success will again crown the efforts of this intrepid airman.

"The Art of Flying" gives the test pilot's view of aviation. Captain Macmillan gives a very clear explanation of the elementary principles of flying, and his book shows what a vast amount of mathematics and mechanics enters into the art of building successful machines. An interesting account is given in more technical fashion, of different types of machines and

engines, with their performances and uses. The author talks about the qualities necessary for a man to be a good pilot, besides giving a description of the strains to which he is subjected when flying under unusual conditions, and the risks taken and work entailed in testing new planes.

The one obvious fact about the flight of birds is that they are not dependent on petrol for the energy necessary to propel themselves along. Mr. John D. Batten explains what is in his opinion the action of a bird's wings in flight, and gives an account of his experiments to produce a machine in which man could fly by imitating the action of a bird, namely, by using his own muscular energy. He describes the stresses and strains involved and the materials used to combine maximum strength with minimum weight. The author submits that such a method of human flight would possess the merits of noiselessness and safety. It would also give the flier exercise at the same time as transportation. But, in competition with modern mechanical aviation, such flight will only be interesting from the point of view of the triumph of the human machine over the forces of nature.

R. S. R.

The Life-Force in the Plant-World of Creative Nature. By ELEANOR HUGHES-GIBB, F.L.S. (Kegan Paul. 5*s*.).

The author's purpose is difficult to define; she wishes to "provide a thread which may serve as a guide, to suggest lines of thought, to incite, to interest, to lead on till a whole group of ideas are gathered together into a harmonious whole." The thread selected is "the life-force at work in the plant-world." This force is the directive influence at the back of the organic and inorganic worlds, some mysterious controlling agency which finds expression in the spirally disposed series of scales on a fir cone and in many other examples of rhythm. In a chapter on adaptability in plant-life the author proposes to follow the roads taken by certain groups of plants in response to the urge of the life-force within them; the structure of the flower is described in simple language, and special attention is given to semi-parasitic and parasitic flowering plants which have chosen "a path of adaptation to difficult circumstances which yet is surely not the true response to the urge of the life-force." In another chapter an account is given of the more excellent way adopted by leguminous plants, which take in paying guests as partners in the all-important work of procuring nitrogen from the air. Insectivorous plants, on the other hand, have been less fortunate in their attempt to utilize insects as a source of nitrogenous food. The dominant idea is the relation of plants to the life-force, the dominating force which blesses the efforts of some of the more fortunate and withholds a full measure of reward from others that have wandered from the path of evolution. In a section on Response the suggestion, attributed incorrectly to Sir J. C. Bose, that the movement of starch grains from one side of a cell to another is the cause of geotropic curvatures, is quoted as "a simple and clear explanation." The hypothesis is attractive, but it has not been generally accepted as a well-established theory. The book may have a good influence in encouraging observation and the habit of putting questions to nature by means of simple experiments, but the effect of the author's determination to regard plants in the light of human beings living in harmony or in discord with some life-force can only be to direct inquirers after truth along the broad and easy road rather than to induce them to follow the straight and narrow path. Miss Hughes-Gibb writes as an enthusiastic lover of nature anxious to induce others to share the happiness which she has found in the companionship with plants; it may be that she would not wish her book to be regarded as a guide to the scientific study of botany.

A. C. SEWARD.

(1) *The Rise of Modern Physics.* By HENRY CREW, Ph.D., Fayerweather Professor of Physics in North Western University, U.S.A. (Balliere, Tindall and Cox. 22*s*. 6*d*.).

(2) *The Romance of Reality.* By BEVERLY L. CLARKE, Ph.D. (Macmillan & Co. 10*s*.).

(3) *New Worlds for Old.* By R. G. LUNNON, M.A., M.Sc. (Methuen & Co. 2*s*. 6*d*.).

(1) Our first book is described by its author as a sketch, but it is really a somewhat comprehensive history of science from the American point of view. Physics is the fundamental basis of all science, and the history of its development is all too little known even by the students of physics themselves. It is the consideration of the history of a subject which enables us to assess its proper place in the scheme of things, and thus tends to prevent that deplorable bigotry which has sometimes characterized the specialist. Dr. Crew's book is good and very readable, but we should have liked more details. We recognize, however, that the subject is so large that it is manifestly impossible to do it justice within the limits of a small volume. The progress of the study of electric discharges in gases has had the most profound influence on the development of modern physics, and it is a pity that Dr. Crew does not give us a little more of the history of this important branch of the subject. The fascinating researches of Hawksbee, Morgan, Davy, Crooks, and Sir J. J. Thomson on this subject are of primary interest and should not have been omitted. Surely the name of Stephenson merits inclusion among those who were responsible for the development of the locomotive. The omission of any reference to him may be due to the fact that the author prefers to regard him as an engineer rather than as a physicist. The illustrations in this book, of which there are some twenty-four, are excellent and particularly well chosen. The reproduction of an engraving by J. G. Murray depicting the young Faraday assisting Sir Humphrey Davy at the Royal Institution in London is most attractive. There is a very good bibliography of the history of physics which will certainly be of value to all students. We can recommend this book not only as a volume of interest to the layman, but also to all students of physics who wish to realize the great traditions which vitalize their profession.

(2) "The Romance of Reality" is a different type of book, also written by an American scientific man. It is a picturesque account of scientific phenomena, and deals in such diverse matters as protoplasmic cell division, relativity, and the solar system. The author states in the preface that the book is not an "outline" nor yet a "story" of science. He has drawn freely upon an undoubted capacity for imagery, which may be of service in providing entertainment for those who are entirely ignorant of science and yet feel that they would like to form some idea of the meaning of scientific discovery. The book should have value as a pleasant means of acquiring a superficial idea of science. Not the least valuable part of this work are the illustrations. They are well chosen and reproduced, and form an interesting portrait gallery of eminent scientific men.

(3) It is perhaps a matter for satisfaction that there have been of late years a large number of authoritative books dealing with science from a popular point of view. It argues a gratifying increase of interest on the part of the general public. Mr.

Lunnon's book is based on a course of university extension lectures, and he deals with the development of physics and the properties of matter in a manner that is not only clear and concise but eminently readable. Mr. Lunnon does not "write down" to his readers, but he gives them a plain straightforward statement of the facts in a clear and interesting manner. The book is well produced and the price low. We have every confidence in recommending it as an excellent example of a simple and at the same time accurate statement of the modern position of physics.

V. E. P.

The Determination of Minerals under the Microscope. By JOHN W. EVANS, C.B.E., D.Sc., F.R.S. (Thomas Murby & Co. 7s. 6d.).

This book, which is an amplification of some of the author's previous papers, supplies a long-felt want because it deals in a remarkably simple manner with the principles underlying the identification of minerals by the examination of their optical characters. After describing the petrological microscope and the properties of light, Dr. Evans proceeds to discuss the methods employed in the identification of minerals as seen in thin sections of rock, and describes in detail the procedure in the examination of minerals by polarized light, and by means of their interference figures. Much of the mathematical detail with which such a discussion is usually accompanied is dispensed with, and the illustrations, of which there are many, are, with one or two exceptions, clear and easily appreciated, so that the book is intelligible to those who have not made a special study of the science of optics.

While it is invaluable to students, as an introduction to the methods employed in petrological research, the book should prove most useful to those concerned with the quarrying, marketing, and use of stone, who may desire to know something of the properties of the material they are handling. There are chapters devoted to methods of determining the thickness of rock sections and the refractive index of minerals, and to the examination of minute crystals and fragments of crystals such as are used in the detailed study of crushed rocks.

The optical properties of individual minerals are not described, but a companion volume dealing with this aspect of the subject is promised, and, it is to be hoped, will soon be available; the two books would then constitute a complete but simple handbook of petrological methods.

F. J. NORTH.

Photographic Art Secrets. With a general Discussion of Processes by WALLACE NUTTING, D.D. (Chapman & Hall Ltd. 12s. 6d.).

This book contains a great deal that will be of practical value to photographers, whether they use a camera purely as a hobby or whether they use it for various professional purposes. The word "art" in the title is perhaps a trifle provocative, but the author shows that he has no illusions in that direction, as many photographers seem to have. It is obviously impossible to regard photography as entirely an art or entirely a science. Most good photography contains a big element of the same instinct for selection and arrangement which characterizes, for example, the work of the painter of portraits and landscapes. But whereas in the painting creation in the art sense continues throughout the whole process of production until the final touch is applied, this in photography can hardly be said to affect the result very much beyond the point of exposure of the plate. Something, it is true, may be achieved in printing and in retouching the negative, and here, too, the artistic instinct plays an important part. But it is at this stage that there arises a divergence of opinion.

One class of photographer aims at producing no more than one perfect print, which is possibly achieved only with a great deal of work on the print itself. The other class aims at producing a negative from which any number of perfect prints may be taken. While there is perhaps no particular reason why these two groups should not exist side by side, it is certainly possible to argue, quite plausibly, that the first group are to some extent misusing their medium, and mixing hand processes with mechanical ones, a thing which to the pedant is not altogether satisfactory. The purist may desire either a good painting or a good photograph, but hardly the two combined.

Mr. Nutting realizes that theoretical propositions of this sort are not really of much importance. He says in his first line that a vast deal of nonsense has been uttered on the subject. "To forfend the quibble that photographs are not art, let us call them artisanship—when they are." He writes for those who wish to take good photographs, and he has nothing to say for those who "gain their pleasure merely from snapping a shutter."

The book contains a large number of specimen photographs which, in themselves, will well repay study and analysis. To each of these, in a final chapter, the author appends a note explaining generally why and how the negative was taken. That they are perhaps in some cases crowded rather too many on a page detracts from their individual qualities, but their quantity—there are over a hundred—is of distinct value.

C. E. H.

The Origin of Instinct: A Study of the War between the Ants and the Termites. By E. BUGNION, translated by C. K. OGDEN. Psyche Monographs No. 1. (Kegan Paul. 5s.).

This book is really a separate publication of Part IV of Auguste Forel's "Social World of the Ants," which was published at the same time. This part, by Bugnion, has been produced separately because it is regarded as an important memoir in connexion with psychology. The first twenty-eight pages are devoted to describing in a somewhat unconvincing way the habits of various kinds of termites in relation to ants. Then follow sixteen pages upon the subject to which the book owes its title.

Many will agree whole-heartedly with the statement put concisely in a footnote on page 29, that "we must of necessity assume intelligent processes at the beginnings of instincts, which are only hereditary habits," but this should have been the text for the whole book. The author distinguishes what he calls three categories of instincts:—(*a*) Instincts connected with defensive measures borrowed from Nature. (*b*) Instincts connected with anatomical structure or, in other words, the defensive organs of insects. (*c*) Instincts resulting from mental dispositions which, being of use in the conservation of the species, have become automatic. Each of these categories is dealt with in an impressionist manner, whereas each of them if properly expanded, would have made an admirable and fascinating chapter.

On page 39 the author states that "it is scarcely possible to compare a colony of insects with a human society," but the only reason he gives for this view is that the more advanced nations place kings, queens, and magistrates at their head but that nothing of this kind happens among the termites. Here

many will join issue with him. We seem to be following very closely the line of evolution of the termites. Whereas primitive human beings recognized chieftains and gave them power of life and death over their subjects, modern monarchs are very much in the position of kings and queens of termites and have to work hard for their living.

In primitive human groups, as in primitive animals, the male was dominant and the female subservient, whereas in modern human groups, as in social insects, sexual distinctions tend to disappear. Among termites birth control is recognized, the queen being fed or starved according as individuals are scarce or plentiful, and among them also the destiny of the offspring is determined by the requirements of the colony. Among the more advanced human societies birth control is now a common topic of discussion, and the struggle for existence is automatically forcing individuals to take up whatever line of work offers a livelihood, regardless of tastes and qualifications. It may well be that, before long, each individual allowed to be born will be detailed to a particular occupation by a democratic government, as in the termites.

The only difference between social insects and human beings seems to be in the amount of intelligence and consequent power of individual adaptability. In the social insects evolution has been in the direction of race memory or instinct. In human beings race memory, although it exists, has never been developed because intelligence has taken its place.

FRANK BALFOUR BROWNE.

A Place among Men. By CAPTAIN GERALD LOWRY, F.R.G.S. With foreword by FIELD-MARSHAL VISCOUNT ALLENBY, G.C.B. (Mondiale. 2*s*.).

Whatever may be the feeling in regard to the scientific ideas set out by Captain Gerald Lowry—the blind sportsman, his story of a game struggle, against what to many may seem insuperable obstacles, will be read with lively appreciation. Field-Marshal Viscount Allenby's remarks in the foreword seem to sum up the work sufficiently. He says, "The book deserves to be widely read and thoughtfully studied. . . . Captain Lowry has found the key to health and happiness, he has unlocked the doors, and has thrown them open that all may enter."

Captain Gerald Lowry, late of the Royal Irish Rifles, was, we learn, not only the first British officer but actually the first soldier to be blinded as a result of wounds received on active service in France. This happened in 1914, after the famous retreat from Mons. Deprived of his sight he resolved to develop other senses to their fullest extent, so that by his example he might encourage others similarly incapacitated.

He has always been an open-air man, and it was a great joy when he found himself able to indulge in his pre-war activities. His first attempt was with swimming. At the start, that exercise proved a joyous relaxation from the strain consequent upon the shock of his wounds. Soon the possession of a sixth sense, which he designates "a sense of atmospheric pressure," enabled him to gauge with accuracy the proximity of the ends or sides of a swimming bath before reaching them. Such remarkable progress did he make that he subsequently won the Bath Club fifty yards swimming handicap two years in succession against sighted competitors.

As his strength returned, he extended his field of physical pursuits. Attaining proficiency with the punch ball, which he had never previously encountered, he took up boxing. In December, 1926, he made his public debut in the ring at Brighton, when he gave a sparring exhibition in aid of the Royal Sussex Hospital. In May, 1927, he crossed over to Paris and gave an exhibition bout at the Sporting Club de France with his trainer, Sergeant Begley, instructor at St. Paul's School, and late of the R.I.C., on behalf of the Société de Phare—the "Saint Dunstan's" of France. At the same time the author took up running, not only on the cinder track but also with the Worcester Park (Surrey) Beagles, and his story here reveals not only his courage, but also a sense of boyish humour which brings back memories of our school days.

Captain Lowry writes of the way in which he keeps physically and mentally fit, and he deals in an interesting manner with the late Dr. A. T. Still's theory concerning the necessity of perfect adjustment of the structures of the body, so that all the parts are kept in their correct alignment, thus enabling an ideal balance to be maintained. He also demonstrates the need for scientific relaxation of the brain and nervous system in these days of speed and high pressure.

This is indeed a book to read, for it tends to give us a truer sense of proportion in many ways, especially when there is a tendency to rail against Fate. To the man against the wall it is a great tonic.

H. H.

Agricultural Economics in the Empire. (H.M. Stationery Office. 6*d*.).

Reference was made in these columns recently to the growth of British colonial agriculture, in which the volume of trade has trebled since 1906, but it is surprising to learn from this new report that for most countries such statistics are entirely wanting. The Empire Marketing Board has therefore advanced a project for a world agriculture census to be taken in 1930. According to the International Institute of Agriculture, of a total of nearly two hundred countries, including colonies, only thirty-seven have taken an agricultural census in the first twenty-five years of the present century. The area of these countries represents a little less than half the land area and about thirty per cent of the population of the world. The remaining one hundred and sixty countries, representing seventy per cent of the total population, have never taken an agricultural census, or at least not within the last twenty years. The expression "census" refers, of course, to a complete enumeration, for some of the countries already issue annual estimates of acreage under crops. Statistics are seldom the "magic numbers" which they are sometimes supposed to be, but obviously the uncertainty in estimating the world supply of agricultural products is at present unnecessarily great.

Tarka the Otter. By HENRY WILLIAMSON. (Putnam).

The latest award of the Hawthornden prize is to Mr. Williamson for this remarkable work. The prize is given annually for the finest piece of imaginative writing of the year, the judges being Mr. Robert Lynd, Mr. Edward Marsh, Miss Warrender, Mr. Laurence Binyon, and Mr. J. C. Squire. In presenting the prize, Mr. John Galsworthy described "Tarka the Otter" as a truly remarkable creation; it was the result of stupendous imaginative concentration, fortified by endlessly patient and loving observation of Nature, and in his opinion Mr. Henry Williamson was the most intimate living interpreter of wild life. The author has come to the conclusion that animals are incapable of mean actions as we know them. Their instincts are uncorrupted—they are the servants of their species. The idea that animals are "lower" than man fills him with scorn.

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Editorial Notes.

THE first public transmission of wireless pictures is to begin this month, when the British Broadcasting Corporation will make a short experiment daily from the Daventry 5 XX station. At first this new service is to take place outside existing programme hours, but later, if it appears that there is a sufficient demand, it will be included in the regular programmes. A system known as the Fultograph will be used, which resembles the "telectrograph" invented by Mr. Thorne Baker and first used nearly twenty years ago by a London newspaper. At that time the photographs sent by this machine from Manchester to London passed over a telegraph wire, but the later development and application of wireless to the method has not altered its essential principle. The B.B.C., in fact, have wisely reminded the public that methods of transmitting and receiving still pictures by wireless should not be confused with television—a warning by no means superfluous in view of the recklessness with which even the leading newspapers continue to confuse these terms. Television, of course, is the seeing by mechanical means of living objects or scenes taking place at a distance from the observer, something quite distinct from the recording of a still picture on an apparatus which by analogy is not unlike a dictaphone. The material of each still picture transmission will consist of "a selection from several subjects." Presumably the most popular pictures should be those connected with sporting events, of which the results have been broadcast vocally an hour or two before.

* * * * *

Television is the subject in the official statements of a further reference which cannot be regarded as entirely satisfactory. The first announcement, dated 8th September, that "no practical demonstration of television has yet been made to the B.B.C.", was later qualified in view of "current rumours" as follows: "The B.B.C. wishes to make it plain that it has not so far been approached with apparatus of so practical a nature as, in the opinion of the Corporation, to make television possible on a service basis." Presumably the current rumours concerned Mr. John Baird's press statement that his company is "quite ready" to begin television broadcasting, and his reported surprise at the official attitude. Without questioning in any way this inventor's integrity, we cannot help feeling that an impartial inquiry is called for. Either the B.B.C. is misinformed or the position of Mr. Baird's invention has been exaggerated. We published in *Discovery* his first article, in April, 1925, and have since devoted considerable space to the subject. It is therefore in the friendliest spirit that we suggest Mr. Baird should now define his position—at a juncture which may well be of historic importance in television—or at least he should censor rigorously the output of certain journalists to whom any want of confidence in his invention is largely due. Meanwhile, a demonstration of the General Electric Company's rival apparatus has been given to the Press in America, where a play was successfully "televised" over a distance of eight miles.

* * * * *

The theory lately advanced in *Discovery* that there may be a surplus male bird population does not meet with the agreement of Mr. E. M. Nicholson, the ornithologist to whose views on territory our correspondent related his suggestion. Mr. Nicholson admits, however, that it is one of those questions which has been neglected for more obvious studies, and that it should be capable of solution by co-operative work on the part of bird observers. Elsewhere in this issue he proposes a method that hinges on the readiness with which birds of either sex replace a mate lost during the breeding season. This factor seems to indicate

a large and mobile non-breeding population always ready to step into gaps, and one way of getting evidence, therefore, would be to catch the hen or cock at selected nests and see how often the operation could be repeated. This might be done with starlings or great titmice—whose sexes are distinguishable in the hand—and in Mr. Nicholson's opinion the value of the data would certainly outweigh the inconvenience to the birds. We hope to publish further details of this problem in order next spring to discover a satisfactory answer.

* * * * *

We remarked recently on the exemption of scientific films from Customs duty, but it appears from a first experience that the new procedure is extremely cumbersome. The admission of a film may be allowed free of duty if its purpose is vouched for by the Royal Society, which has, however, to issue its certificate not to the society applying for exemption from duty but to the Customs authorities. Accordingly, the secretary of the International Congress of Orientalists wrote to the Customs authorities, on behalf of Dr. Rathjens of Hamburg, who desired to illustrate his lecture to the Congress with a film. More than a week passed before the arrival of a reply, which asked the length of the film, whether positive or negative, and other details scarcely relevant if the film was to be exempt from duty. A further letter to the Customs authorities produced more complications, including the proposal that in view of the short time before the meeting the duty should be deposited pending the Royal Society's attention to the matter; it was added that the Customs "Commissioners *understand* that the duty on a positive film of this length is *about* £31 10s." (the italics are ours). Whatever views are held on the merits and otherwise of a duty, it is surely reasonable to expect that the authorities concerned should be able to specify precisely the extent of their charge. To cut a long story short—it was given in full by Professor J. L. Myres in an admirable letter to *The Times* on 4th September—the Congress took place without the film, and it was necessary at the last moment to withdraw Dr. Rathjens' paper from the proceedings. To say the least, this is hardly an encouraging precedent.

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On another page appears a short account of a few of the most interesting papers delivered to the British Association. The authors of papers addressed to the Association make no attempt to popularize their contents; the increased public interest in the meetings being entirely due to an increased appreciation of the aims of research, and a desire to know more than the basic facts of the various branches of science. In 1831, when the Association held its first meeting in York, the leading newspapers thought fit to ridicule the idea of the general public taking any interest in science; but what newspaper to-day would reject the "publicity value" of a new aspect of the theory of evolution or of a new scare about the possibilities of the "death ray"? The manner of presentation of the results of scientific research has, indeed, become a matter of serious concern to those who consider the interests both of science and of the public. Glaring headlines may often bring more ridicule than praise on the results of brilliant research; and the flow of journalistic language may mould as well as distort the popular conception of scientific issues which affect the welfare of the public.

* * * * *

The diary of Philipp von Neumann, an Austrian diplomat who held appointments in England from 1814 to 1844, has been discovered by General Sir George Aston. Extracts are appearing as we write in *The Times*, before publication by Messrs. Philip Alan. The general impression afforded is how little social conventions have changed in a hundred years by contrast with the revolution in intellectual conceptions. We can sympathize with a comment that the company "were regaled with a dinner and a family concert afterwards which upset our stomachs as much as our ears," but there is an almost mediaeval picture in the entry for 14th October, 1819:—

> A very curious case was heard to-day at the King's Bench. A Mr. Carlile had published a work by Thomas Paine proving that the Bible was filled with absurdities, obscenities, and other scandalous matter. He had cited as witnesses the Archbishop of Canterbury, the Chief Rabbi, and the Astronomer Royal, Mr. Bond, in order to examine them, and above all to get the last to explain how it was possible for Joshua to make the sun stand still before Jericho. The scandal caused by this man during the trial so affected the jury that they condemned him without hesitation.

* * * * *

The Radio Research Board has just issued its report on wireless observations made during the solar eclipse on 29th June last year. These show that the eclipse produced a very definite effect on the properties of the ionized layer of the atmosphere responsible for deflecting wireless waves of 300-400 metres back to the ground. The most striking effect was the large increase in the intensity of the downcoming ray, which was detected at both near and distant receiving stations. The results as a whole seem to suggest that the more southerly receiving stations experienced the maximum eclipse influence a little earlier than the northern stations.

The Bishop's See of Ancient Greenland.

By Poul Nörlund.

The National Museum, Copenhagen.

During the summer Professor Nörlund has excavated the remains of the thirteenth-century bishopric in Greenland. A bishop's skeleton with gold ring and carved staff—the first works of art brought to light from these Norse ruins—are among the important discoveries.

In the western European countries, which suffered from the Viking invasions of long ago, people are often amused and occasionally perhaps amazed at the unblushing pride which we Scandinavians take in our wild and savage forefathers. For truth to tell, the majority of them, whenever they appeared, brought trouble or even disaster to peaceful folks. But a few figures stand out from the bloody horde, not because of a greater chivalry or humanity, but because, in addition to the romantic ferocity of their history, there was also about them a certain cultural air of a particularly magnificent kind.

Such a figure, standing head and shoulders above the rest, was Eric the Red, the discoverer and colonizer of Greenland. Of his grim character we have more than sufficient evidence. For manslaughter in his youth he left Norway with his father and set out for Iceland. For a second homicide he was sentenced in Iceland to banishment from his adopted country. As an outcast he set out once more upon a voyage of discovery across the dangerous western ocean, and found here—hidden behind the drifting polar ice-belt—the smiling Greenland fjords, which offered to frugal peasants conditions equally as good as those in many parts of Iceland or northern Norway. He was not one of those discoverers who were satisfied by merely seeing a country once, and then leaving for ever what they had found. He brought settlers from Iceland and established in Greenland quite a little "kingdom" of his own, which continued for nearly five hundred years (approximately A.D. 1000-1500) as a distant outpost of European civilization, first as an independent republic, and later as a feudal state under Norway.

SITE OF THE EXCAVATIONS.
General view of the settlement at Igaliko, formerly the site of the cathedral and Bishop's see, where the new excavations were made.

About the time when the southern Europeans discovered America, however, these Norsemen lost touch with Europe, and after the lapse of some time they must have perished. The population died out, the houses collapsed, and grass and willow undergrowth covered the ruins. Eskimo tribes settled on the points and promontories, but inside the fjords, where the Norsemen lived, everything became silent and still. For centuries all human life stagnated, and a wanderer visiting these parts might well walk for days without finding any signs of life, other than a frightened, nervously cackling grouse or an eagle circling in unfathomable silence over his head.

The remains of Norse habitations are still to be discovered almost everywhere in these parts. It sometimes happens that traces of a path are found, leading straight up to the ruins of a stone house. This path was made by the peasants walking for centuries along it upon their daily journeys to and from the well, the pond, or the landing stage, and even the ages that have elapsed since then have not succeeded in effacing it entirely. The grass upon it is shorter and thicker and of another colour. The ruins are well hidden by the undergrowth, and they are easily missed upon a first search; the surest signpost is usually found in the fresh green of a former midden, gleaming brightly from the brown grey moors.

In fact, in the firths of southern Greenland, where all human activity now has been dead for centuries, there is hardly a spot which the old-time peasants did not try to turn to account. Every valley had its farm, every hill slope its sheep fold. Even the smallest rocky islet, and tracts of land stretching right in under

the fringe of the inland ice were utilized. The country was really "fully inhabited," as they put it in the old reports. Thus there is an example of the culture of the Middle Ages hidden away here in South Greenland, more undisturbed than would be possible to find almost anywhere else in Europe, an exceptionally fascinating field of research for archaeologists.

The Danish State, represented by the Commission for Scientific Investigation in Greenland, has sent a number of expeditions there to find and examine these northern remains, and the last two of them I had the honour of leading myself.

A Prosperous Colony.

It might perhaps be assumed that necessarily a poor and primitive form of culture must be found in these distant places, with hardly anything of interest to the general cultural history of Europe. But this assumption has proved somewhat erroneous. During our expedition to Herjolfsness in 1921 we had found a large number of dresses of the Middle Ages, which might possibly be called poor, in that they were woven of simple wool, as well as the Greenland women were able to weave them, but which in their cut and style are faithful copies of the European fashions of that time. The hoods (chaperons) with the long tail hanging from the back of the head, or the long ample skirts, which with but little difference were used by both sexes, are almost the only everyday dresses of the European Middle Ages now extant, and if only for this reason, therefore, are naturally of considerable interest.

Our finds at Herjolfsness gave us some insight into the tragic end of these Norsemen, for anthropologists have been able to read from the skeletons found that they were those of a population greatly degenerated by intermarriage and malnutrition. There is something very touching about the fate that met these brave and long suffering colonists, who, after being left entirely to themselves, slowly perished, either of actual hunger or by the arrows of the Eskimo natives. But in spite of their tragic end, it is important to recall the prosperous times which these colonies also enjoyed; and to throw some light on this period, we turned our attentions during our latest expedition to the old see of the Greenland bishops at Gardar (now Igaliko).

Christianity came to Greenland in the first generation after the Icelanders settled there. Eric the Red certainly was a steadfast heathen, but his own son Leif brought missionaries in his ship from the British Isles, and Eric's wife is said to have built the first Christian church in Greenland. For a whole century or more they lived without any regular Christian organization. The peasants, who had built churches usually upon their own farms, as was the case in Iceland, attended to the priestly duties themselves. This practice was a relic of heathen times when the most important farmer was himself the sacrificial priest and the representative of the Godhead. In order, however, to maintain the faith over successive generations, it became essential to establish an independent bishopric in Greenland, and it is a tribute to the Greenlanders' own cultural virility, that they undertook the establishment of this bishopric themselves. It was not a task forced upon them by others, but in Scandinavia their request was soon granted, and for centuries the Norwegian church sent over bishops—and among them highly distinguished prelates—to this little episcopal see which, with its fifteen churches and 2,000 to 3,000 people, formed hardly more than a tenth part of a normal diocese. The first bishop, Arnald, went to Greenland in 1126, and was given a dwelling at Gardar, where the peasants had set aside one of the best farms in the settlement as the "bishop's palace." This place is one of the few where modern Greenlanders have also settled.

Our first impression, on arriving there, was one of great disappointment. Where were the many ruins, which we had heard about from former visitors? We saw now only huts of the usual type used by modern Greenlanders. Alas! we soon found the explanation; the beautiful, regular stones of which the huts were built, had all been taken from the old ruins. For 150 years the inhabitants have been pilfering stone from the Norsemen's houses, and now every part of the low walls standing above ground level has disappeared. Some of the Eskimo huts

ESKIMO FARMERS TO-DAY.
Hand threshing is here seen in progress, the modern inhabitants using the site of the ancient bishop's farm for their operations.

certainly looked a little peculiar. There were, for example, a couple of outhouses for winter fodder for the domestic animals, of which the roof consisted of a single enormous block of stone, some five tons in weight. (See photograph.) Now this is not the sort of work that the modern Greenlander would care to tackle, as everyone knows who has had anything to do with him. It was then discovered that these outhouses originally had formed the entrance portals of Norse dwelling houses. The roof was simply the top stone of the portal, and the Greenlanders had merely added a wall at either end of the passage to make what, to their ideas, was an easily made and roomy tool-and-provision shed. A better example of the difference between now and then—between the natives of small stature and the virile brawny fellows who lived there in the Middle Ages—could hardly be found than that of an old porch which originally connected

THE RUINS OF THE CATHEDRAL.

Excavation in some turnip fields revealed the cathedral walls, which served as the foundation for modern walls used to divide one allotment from the next.

two rooms in a cowshed now forming a whole house for the modern Eskimo.

During the summer we excavated a large number of ruins, as fortunately the natives had been unable to remove the foundation stones. It was a surprisingly comprehensive and ambitious lay-out when we remember how far away from civilization it all was. The cathedral, the first building to be cleared, must not, of course, be compared with those in Europe or even in Scandinavia, for in comparison it dwindles into a mere country church. After all, it is possible in that way to make almost anything appear small. The one thing to do is to find the right measure, and here we find one ready to hand. Iceland was the mother country of the Greenland colonists, and thus in the Saga island we find the best measure with which

ANCIENT AND MODERN STONEWORK.

Porch covered with a stone of five tons weight in an ancient cowshed, now used as a bivouac by the modern Greenlanders.

to appraise properly what we find in Greenland. It is seen, surprising as it may be, that the old Greenland parish churches, or "peasant" churches, which have been excavated during the last generation, are considerably *larger* than their Icelandic equivalents. And, from what we know, the bishops' churches in Iceland during the Middle Ages seem to have been in no way larger or better than that in Greenland, although the two Icelandic bishops were the spiritual heads of over 330 churches.

So it was with the bishop's "palace"—the actual dwelling used by the bishop and his retainers. We found it, after careful search, hidden away in the Greenlanders' turnip fields, where the former walls served as the foundation of the stone walls now dividing one small allotment from the next. Each single room thus forms a separate little field all to itself. Of these rooms I will mention only the reception hall, where great festivals were held on such occasions as the gathering for the annual parliamentary meetings, which took place upon the Gardar plain, and for the important church celebrations, especially that of Christmas. Christmas even from heathen times was celebrated as a solstitial festival, for in mid-winter the sun rises above the mountains for a couple of hours only, and the festival marked the date from which the days were about to lengthen again.

The bishop's reception hall measured 16.7 by 7.8 metres, or about 130 square metres. This is quite a respectable room even to our ideas; but only by searching the old historical records can we realize how many guests it was possible to regale in a room of this size. Here, again, it is the Icelandic comparison that we use as a measure. One of the most powerful men in Iceland's famous Middle Ages was

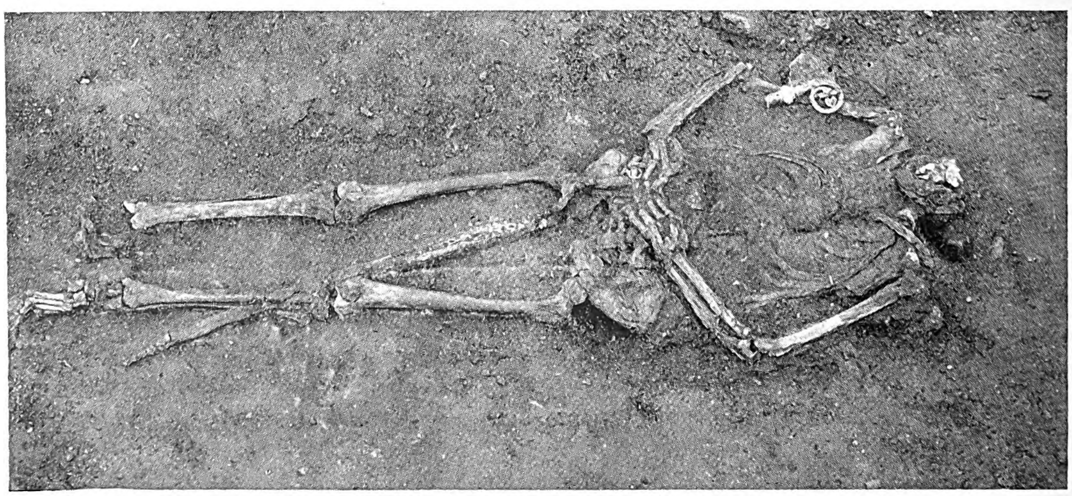
one Gissur Thorvaldsen, who was appointed earl of his native island by the Norwegian king. In 1253 Gissur celebrated upon his farm at Flugumyre in north Iceland his son's marriage with a daughter of another great Icelander, one Sturla Thordsen. The wedding was made grimly notorious by the murderous fire which concluded the ceremonies, and in which twenty-five people perished, the bridegroom among them.

The Bishop's Hall.

The Saga describes this wedding in detail, referring to it as the most magnificent ever held in the Iceland of that time. In the hall more than 200 people sat down to eat, in six rows one behind the other, and we are fortunate enough to learn the exact measurements of this drinking hall, presumably because they seemed so enormous to the story-teller himself. In modern measure it was 68 square metres, that is to say, only a little more than half as large as the Gardar Bishop's Hall. In Trondhjem (Norway) the Norwegian Archbishops' Festival Hall (Hall of Knights) is still preserved. It is only 3 metres longer and 1½ metres broader than that of Gardar.

Of the extent of the farming upon the bishop's land we may also draw our own conclusions from the ruins, and we are bound to admit that it must have been considerable. Besides a number of small sheds for sheep and goats, horses and pigs, there were two cowsheds, the largest being 75 metres long, and the two together being large enough to house several hundred cows! We must assume that these sheds were not built bigger than circumstances required; but it is certainly puzzling to discover whence was procured the winter fodder to feed all these animals. There was certainly an enclosed home field (tun) of about forty acres, which in relation to Icelandic proportions is no mean size. The cattle were not allowed to graze here in summer time, but the greater part of this field is now quite barren and the whole does not yield many cartloads of hay. A couple of meadows have also been walled in. In all, the enclosing walls are about 1,200 metres in length, all of them low, but very strong, being at least one metre thick and obviously the result of the expenditure of much labour and time.

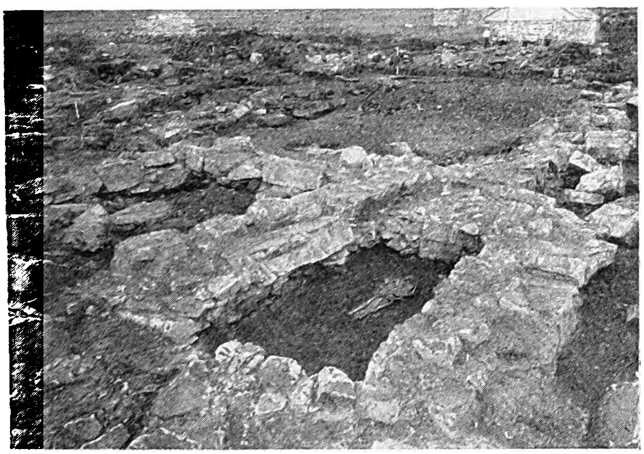
The ruins on the Gardar Plain tell their own story plainly enough, broken and uncared for though they be. They tell us of a strong and virile people, full of life and energy and ready for any work that came to hand. The bishop's farmhands did not lounge about at a loose end the whole summer through, while the cattle out grazing could be tended by few. This is proved by the numerous walrus' skulls, which came to light wherever we began to dig. The skulls are reminders of the great summer journeys which took the hunters often hundreds of miles away, northwards along the west coast of Greenland, or around the southern point to the dangerous ice-bound east coast, seeking for the big sea creatures from which they procured valuable trade articles. These were so much in demand in Europe that European merchants were even tempted to make the journey to Greenland to buy them. Soft furs and heavy skins were obtained, and above all the white tusks of the walrus and narwhale which were sold all over northern Europe as ivory. Even Peter's Pence to the Pope were then paid by the Greenlanders in walrus tusk.



THE BISHOP'S SKELETON.
The carved staff is seen lying across the right arm and the bishop's ring is on the same hand. The right foot has been lost, probably due to gangrene, while the damage to the cranium was caused by a later interment on the same site. The grave dates from about 1200.

I have related something of the bishop's palace and of the cathedral, the background of the bishops' activities in this far off country. Of the bishops themselves little is known beyond their names, and occasionally from historical records the dates when they came out and when they returned home. It was therefore a great satisfaction to us when we succeeded in finding a bishop's grave in the cathedral. It was the most important event of the summer's research work.

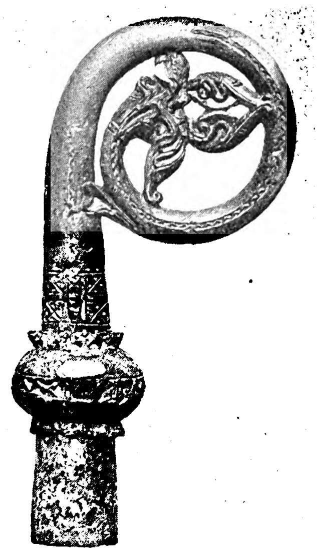
Among the pebbles under the floor of the North Chapel we discovered one day a little piece of bone with an ornamental design carved upon it, and it aroused a definite hope among us all. For over two days excavations were carried on extremely slowly and carefully; it was important that nothing should be destroyed or damaged. From hour to hour the carved piece gradually emerged, until it began at length



THE BISHOP'S GRAVE.
This view of the northern chapel at Gardar shows the bishop's skeleton in the position of its discovery. No coffin protected the corpse.

to take a curved shape. We knew then that it really was the spiral curve of a bishop's staff which we had found, carved in walrus tusk, the most valuable material in the country. When the surrounding debris was finally removed and the crook lay there in all its gleaming dark-brown beauty, with its characteristic carvings, we could not but feel a certain reverent awe. For the first time a work of art had been brought to light from the old Norse ruins in Greenland.

The further uncovering of the fragile skeleton to which the staff had belonged was hardly less difficult. The exciting question was whether the bishop's ring was also preserved. Sure enough, it encircled still the ring finger of his right hand, where it had been placed by the Norwegian archbishop at his solemn consecration in Trondhjem Cathedral. Both the gold ring and the carvings on the staff indicate the time as about 1200, but just at the beginning of the thirteenth century several bishops followed one another quickly in succession, so it would be difficult to say with any degree of certainty who it was that lay buried here. He must remain anonymous as "the Bishop of Greenland 700 years ago," and so will we reverence his memory. Far too many of his clerical brethren left for home again after only a short time in office, or did not even venture to come out at all! Conditions were naturally not exactly inviting for a spoilt prelate, but here was one of them who had remained with his congregation.



THE BISHOP'S STAFF.
Delicately carved in walrus tusk, the most valuable material in the country.

The bishopric and the trade interests were the only two links which bound Greenland to European civilization. Thus was forged a fine chain which reached right down to Rome. The bishops travelled all the way down there after their appointment, and so even the Pope himself received some knowledge of the conditions existing in this his most distant diocese. It was, however, a limited understanding which was acquired, for example, in 1270 the northern countries received a flat refusal to their application to be allowed to use a substitute for grape wine and wheat flour for altar wine and oblations. At the Papal Court they appeared unable to grasp the fact that both Iceland and Greenland lay so far away that sheer necessity made them tolerate substitutes if the Sacrament was to be given at all.

In 1377 the last bishop who resided in Greenland died. For yet another 150 years the Popes continued to appoint new bishops of Gardar, but they were only titular bishops, who never visited Greenland nor attempted to do so. It was one of the great faults of the Catholic Church at that time, that such abuses could take place. But the evident reluctance of the bishops is one of the first evidences of the critical condition of the Norsemen in Greenland; just as their presence out there had been the strongest expression of the importance of the settlement.

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The Chemistry of the Stars.

By A. Vibert Douglas, Ph.D.

Macdonald Physics Laboratory, McGill University, Montreal.

New facts discovered about the chemistry of the stars have altered former ideas, and the whole question of stellar evolution is at present under reconsideration. Theories which seemed tenable two or three years ago are either abandoned or regarded with caution.

THE chemistry of the stars is fortunately not very complex. By far the greater proportion of the matter in the universe is at tremendously high temperatures. According to a recent estimate, ninety per cent of all matter is at a temperature exceeding 1,000,000° centigrade. Here the physical conditions are comparatively simple and molecules are unknown, for the atoms themselves are disrupted into free electrons, protons, and atomic nuclei, all moving about with tremendous velocities in a medium literally filled to bursting-point with penetrating radiation. This is the picture of the interior of a star.

At more moderate temperatures, perhaps 20,000°, most of the atomic nuclei have captured a sufficient number of electrons almost to balance their positive electrostatic charges, while at somewhat lower temperatures most of the atoms are fully equipped with their requisite numbers of orbital electrons and at about 12,000° the linking together of atoms to form simple molecules commences. Down even to the temperature of 3,000°, however, the tendency to aggregate into molecules is not very marked, and only about a dozen chemical compounds are recognized. This is the state of affairs in the atmospheres of the stars.

Thus it is evident that the chemical conditions which we have on the earth are not representative of the universe as a whole. The perhaps not unique but certainly very exceptional conditions of temperature and pressure on the earth have favoured the synthesis of complex inorganic and yet more complex organic compounds, but these diverse forms of matter are not typical of the universe.

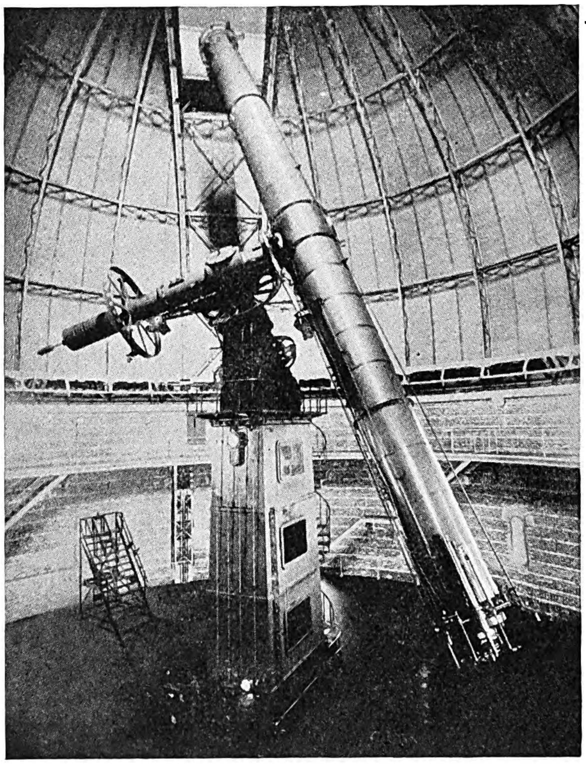


FIG. 1.

FORTY-INCH REFRACTOR.

This giant telescope of Yerkes Observatory, whose lens is 40 inches in diameter, is 62 feet in length and weighs, with its counterbalancing weights and all the moving parts, about 20 tons. The dome is 90 feet in diameter.

Photograph by Prof. F. E. Ross, Yerkes Observatory.

How is the chemistry of the stars studied? Obviously it must be learned from the only thing the star sends to us, namely, electromagnetic energy. The secrets of its nature are imprinted in the starlight. It thus becomes a question of spectroscopy—the analysis of the starlight and the decodifying of the message. Sir Isaac Newton laid the foundation stone when he investigated the prismatic refraction of light in 1672. Fraunhofer first carefully observed the many dark lines in the spectrum of sunlight, Kirchhoff first explained them. The cooler atoms in the outer atmosphere of sun or star are absorbing just those radiations which they would themselves emit if they were at a sufficiently high temperature to radiate, hence it is possible, by matching up absorption lines occurring in a stellar spectrum with well-known emission lines produced in a laboratory by raising known elements to incandescence, to identify the elements in the stellar atmosphere. This was done by Sir William Huggins, Sir Norman Lockyer, Father Secchi, and other pioneer astrophysicists.

Stellar spectra are now photographed at most of the leading observatories. Either the starlight passes first through the telescope and then through the prisms to the photographic plate (see Figs. 1 and 2), or else the prism is placed in front of the objective glass of

the telescope, and then the light passing on through the telescope falls on the photographic plate. In the former case one star at a time is photographed, in the latter arrangement all the stars in the field of view impress their spectra on the plate simultaneously.

Careful study of stellar spectra shows that there are many different types, but that they grade imperceptibly one type into the next. They were classified at Harvard Observatory in a sequence of increasing complexity of appearance, but subsequently it was realized that an order was possible which represented the changes resulting from gradually decreasing temperature. The main portion of this sequence is shown in Fig. 4.

Of the ninety-two elements recognized by modern atomic physics only two remain unidentified by chemical or by spectroscopic analysis of terrestrial matter. The elements not as yet detected in the stellar spectra are sixteen in number, namely: boron, fluorine, neon, phosphorus, chlorine, argon, arsenic, selenium, bromine, krypton, antimony, tellurium, iodine, xenon, gold, and radon. In addition to these there is considerable uncertainty with regard to some of the elements known as the rare earths and the following other elements: beryllium, germanium, indium, tantalum, tungsten, osmium, iridium, platinum, mercury, thallium, bismuth, thorium, uranium.

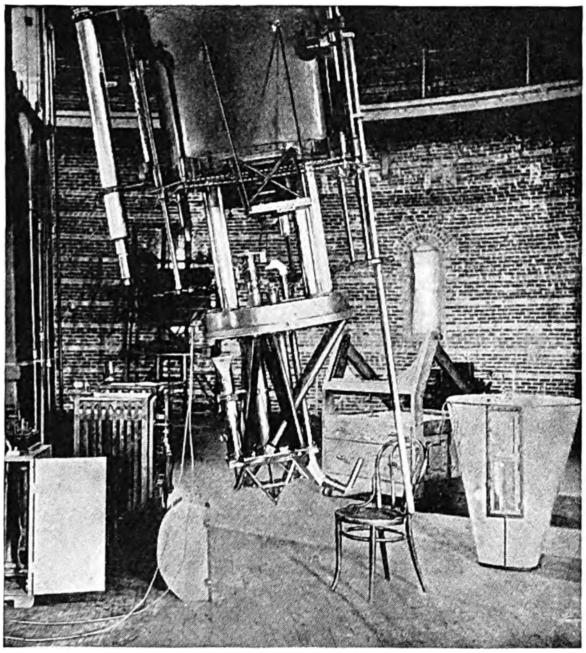


FIG. 2.

THE BRUCE SPECTROGRAPH AT YERKES.

The spectrograph is attached to the lower end of the great Yerkes telescope. The light from the star, focussed by the telescope on the slit of the spectrograph, is made to pass through one, two or three prisms before falling on the photographic plate. To ensure steady conditions the spectrograph is enclosed in the constant temperature case seen at the right of the photograph.

From a Yerkes Observatory photograph.

It should be remembered, however, that because the lines typical of these elements are not definitely identified in the stellar spectra, we need not draw the conclusion that these elements are absent. Various factors might enter into the question—the conditions required to excite the radiations or absorptions might not be exactly those of the stellar atmospheres, or the typical lines might fall in a region of the spectrum not obtainable, that is, too far in the infra-red or too far in the ultra-violet to be photographed. The amazing thing is not that so many elements are unidentified, but that so many are known beyond any shadow of doubt to be present in the stars.

The spectra of the hottest stars reveal the presence of hydrogen and helium and many ionized atoms of various elements, that is, atoms with an excess positive charge owing to the fact that not all the required electrons have been captured by the nuclei. An atom lacking one electron is said to be once ionized, if two are missing it is doubly or twice ionized and so on. In these hottest stars are ionized oxygen, nitrogen, carbon, silicon, calcium, magnesium, and the first four of these also appear in the twice ionized state.

As we pass to somewhat cooler stars some of the ionized lines fade out while others appear and also many lines due to neutral atoms—iron, titanium, strontium, barium, vanadium, aluminium, etc. It is at this stage, in the Class A stars, that molecular structure first puts its impress on the spectra. A molecule radiating or absorbing light does not do so as distinct lines but as one or more bands. Thus a whole region of the spectrum will be affected if molecules are absorbing light in the star's atmosphere, and a dark patch or band is produced, usually sharply defined at one extremity and gradually fading off at the other. This is best seen in the K and M stars in Fig. 4. In the A stars band structure is first seen and is due to the carbon nitrogen compound cyanogen.

A striking feature of a yet cooler spectrum, the solar type of Class G, is a narrow band at wave-length λ 4314, known as Fraunhofer's G-band, identified by Newall, Baxandall, and Butler with some hydrocarbon molecule. Stars cooler than type G whose spectra are chiefly distinguished by the bands of cyanogen, carbon monoxide, and hydrocarbon, are classified R and N according to the development of these bands.

The majority of the stars cooler than Class G stars, however, are not of Classes R and N, but belong to what is known as the *main sequence*, which terminates with Classes K and M. Their spectra are free from the bands of carbon compounds, but in the M stars

the bands of titanium oxide are the dominant characteristic. No star is known whose spectrum shows both carbon compounds and titanium compounds, these two seem to be mutually exclusive. A small class of the cooler stars, very analogous to the M stars, are designated as Class S. Zirconium oxide bands are present in their spectra. Occasionally, but not always, titanium oxide is also present, but the zirconium oxide molecule appears to persist to higher temperatures than the former molecule can stand. Fig. 3 illustrates the sequence of stellar types above mentioned, though one cannot attempt to read into the diagram a simple evolutionary scheme. The whole question of stellar evolution is at present under reconsideration. New facts have altered old ideas. Theories which seemed tenable two or three years ago are either abandoned or regarded with cautious suspicion.

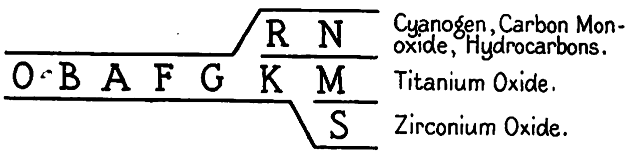


FIG. 3.

MAIN SEQUENCE OF STELLAR SPECTRA AND BRANCHES.

This diagram illustrates the sequence of stellar types, as exemplified by their spectra, though one cannot attempt to read into it a simple evolutionary scheme.

The spectrum of sunspots presents an interesting field of study, for their conditions are not typical of the undisturbed solar surface. Vast vortices of rising gas suddenly reach a level of lower pressure in the higher portion of the sun's atmosphere and, rapidly expanding, the gases cool down producing absorption spectra more nearly resembling that of stars of Class K. Sunspot spectra reveal the presence of water vapour and magnesium and calcium hydride. Bands of ozone and water vapour do appear in the spectra of stars but can be shown to be of telluric origin, that is to say, to be effects produced in the spectrum as a result of the passage of the light through the earth's atmosphere. If these bands were strengthened in the spectra of sunspots and the cooler stars, this would be evidence of the presence of these compounds at the source. This is so with the water vapour but not with the ozone. Theoretically ozone might be expected in the atmospheres of M stars, for Fowler and Strutt calculated its maximum thermal formation to be at a temperature of 3,500° centigrade at a pressure 10^{-7} atmospheres, conditions probably existing in the outer portions of the M stars.

In the ultra-violet spectrum of sunlight the bands due to ammonia have been identified by Fowler and Gregory.

The spectra of the planets are, of course, due to reflected sunlight, but they show certain absorption bands not present in direct sunlight and therefore due to the planetary atmospheres. In the case of Venus and Mars the effect is almost negligible, but Jupiter, Saturn, Uranus and Neptune certainly have atmospheres differing somewhat from that surrounding the earth. Unfortunately the bands in their spectra are of unknown origin as yet. Chlorophyll may be responsible for some of the bands, but the evidence is inconclusive.

The spectra of comets exhibit many features of interest. There are several bands as yet unidentified, while other conspicuous bands are due to carbon monoxide, cyanogen, and the hydrocarbons, possibly acetylene and methylene. The elements responsible for the line spectra are hydrogen, helium, sodium, and iron. Meteors are generally supposed to be typical of the material composing the head of a comet. This seemed definitely proved in the case of Biela's Comet, which returned once or twice showing signs of disruption and then was seen no more, but in its place at the appointed time there came a meteoric shower of considerable brilliance. The analysis of meteorites is therefore of significance—iron, nickel, calcium, silicon, gallium and rubidium.

In the nebulae, the spectroscopist has found hydrogen, helium, carbon, nitrogen, and several strong broad lines usually referred to as "nebulium" lines. Many speculations have been made regarding these. In the autumn of 1927, Dr. Bowen of California calculated how much energy would be emitted by certain unusual electron movements in atoms of ionized or doubly ionized nitrogen and oxygen, and found very good agreement with many of the nebulium lines. In support of this explanation of the nebulium lines Professor A. Fowler added further evidence, but the question remained :—If oxygen and nitrogen produce these lines, why do we not also find in the spectrum the lines most frequently associated with these ions?

An answer to this was given by Professor Eddington in December last. He drew attention to the change in the relative intensities of probable and improbable emission lines when the stimulating radiation is exceedingly weak, and the density of the gases of the nebula so low that once an atom has become ionized it will wander far and wide before encountering a free

electron which it can capture to complete its full quota. The picture we form, therefore, of a gaseous nebula is this: a vast expanse of space (so vast, indeed, that our whole solar system would be but an insignificant portion), filled with about as much gas—hydrogen, helium, oxygen, nitrogen, carbon compounds and so forth—as would altogether make up a mass equivalent to our sun. This tenuous gas is not at a very high temperature, but is being traversed by the light from nearby stars. Much of this light is absorbed by these tenuous gases and then re-emitted in the manner distinctive of the nebular conditions.

The chief debt of the astrophysicist to the chemist is in the development of ionization theory. The physical chemist has elaborated the theory of dissociative equilibrium. Saha, a distinguished Indian astrophysicist, realized that there was a logical analogy between this problem and the problem of ionization in a star's atmosphere. We know that electron bombardment upon a gas, or the passage of X-rays or other penetrating radiation, will disrupt some of the atoms of the gas, thus producing ionization. But ionization can come about in the absence of these agents. This *natural ionization* occurs spontaneously, the energy needed to expel the electron from the atom being drawn from the environment, which thus becomes cooler. This has proved to be a very fruitful line of investigation, but space will not permit of its discussion in this article.

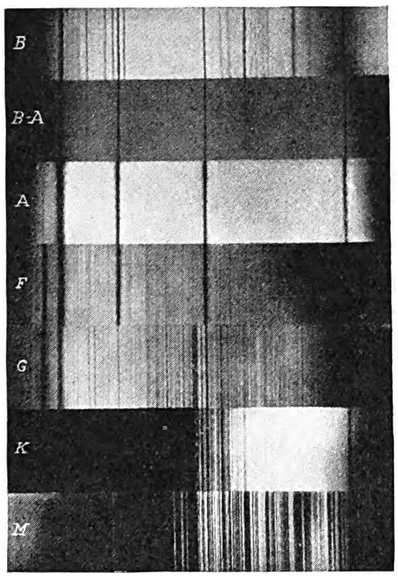


FIG. 4.

TYPICAL STELLAR SPECTRA.

Well-known stars whose spectra exhibit these typical features are the following: Early B—ε Orionis (Alnilam); Later B—β Orionis (Rigel); A—α Canis Majoris (Sirius); F—α Canis Minoris (Procyon); G—α Aurigae (Capella); K—α Boötis (Arcturus); M—α Orionis (Betelgeuse).

Photograph by Harvard College Observatory

Chemists, for the most part, think in terms of molecules. Biochemists, in particular, are wont to think of some very large molecules. Haemoglobin, for example, the red corpuscle in the blood, is a molecule of sufficient size and complexity to appal the average mind, for it is said to comprise about 100 carbon atoms, 200 hydrogen atoms, as well as many atoms of iron and other elements. Let not the chemist, however, boast of his giant molecules, for if it came to a contest as to who could think of the largest molecule, it would not be the chemist who would carry off the palm of victory. The astrophysicist would stand easily first.

There is a class of stars, of which the companion of Sirius is the best known example, called the white dwarfs. Hidden from view beneath the atmosphere of such a star, so much matter is packed so closely together that its density is about 50,000 gms. per c.c., or, in other words, one ton of matter is packed into every cubic inch of space inside the star. Observation and calculation point to this tremendous density and spectroscopic results confirm it, but can one explain it?

The explanation took this form. When we think of the compression of any substance, we picture the limiting density as being attained when the atoms or molecules have been pressed shoulder to shoulder, as it were. Greater density is only possible if each atom can itself be reduced in size. Now the effective volume of an atom is determined by the radius of the orbit around which whirls its outermost electron. The volume of the atom cannot be greatly reduced by compelling the electrons to move in nearer and nearer to the nucleus, but the volume can be reduced, and reduced many thousand-fold by removing the electrons altogether, that is to say, by completely ionizing the atoms. Our substance is then reduced to a gas made up of myriad electrons each having a diameter of only 0.0000000000001 cm. and each moving with incredible rapidity unconstrained to any orbit, and of the atomic nuclei which, though they be over a thousand times more massive than the electrons, are a thousand times smaller in diameter. Such a gas may be compressed to densities far exceeding that above mentioned. This is apparently what has happened in these white dwarf stars, and in order to maintain their complete or almost complete ionization it is calculated that the temperature within the star must be almost incredibly high—of the order of 100,000,000° centigrade.

Just here a grave difficulty arose. The old physics teaches that the higher the temperature of a mass of matter the more intense will be the outflow of radiant energy from it. Thus our hot dense star, which to grow denser must grow hotter at its centre, ought to be radiating more and more fiercely as it grows older. But its total energy is finite, and hence the apparent contradiction that the time will come when its store of energy is almost exhausted, it will want to cool down but will not have retained sufficient energy to expand or lift its outer layers against gravity.

Such a perplexing situation can never arise in the natural world—it must be our physics that has led us astray.

We of this generation have seen the birth of the new physics, and though few as yet have grasped its full significance and mastered its principles, all may gain some idea of its line of thought and gaze with wonder and admiration at what the new methods have already achieved.

The new methods of physics have been applied by Mr. R. H. Fowler of Cambridge to this problem, with results which may be stated somewhat thus :—There are two definitions of temperature. One states that the faster the motions of the atoms or molecules, the higher is the temperature, and *vice versa ;* in other words, temperature is a measure of the average speed of the particles. The other definition states that temperature is a measure of the ability of a body to radiate. Under terrestrial conditions these two definitions agree perfectly and the old physics regarded them as synonymous ; but the new physics show that we cannot generalize and deduce that under all extreme conditions these two definitions will agree. Indeed, they begin to diverge very greatly when very dense matter is being considered. In our dense star the velocities of the free electrons and atomic nuclei are approaching the highest velocity possible, and hence one definition says that this is the hottest matter in the universe. But this very density means that any one particle has no choice as to where it will go next. There is possible but one place and one speed for each particle at any instant. Radiation depends upon there being freedom of motion, choice of next position for any particle, and hence where all such freedom is denied there can be no radiation. Hence by the second definition such a star is approaching the absolute zero and is therefore the coldest matter in the universe. Furthermore, matter in this condition has become strictly analogous to a molecule containing no excess energy which it can radiate away, and so the ultimate state of a white dwarf star is that it will be one great molecule.

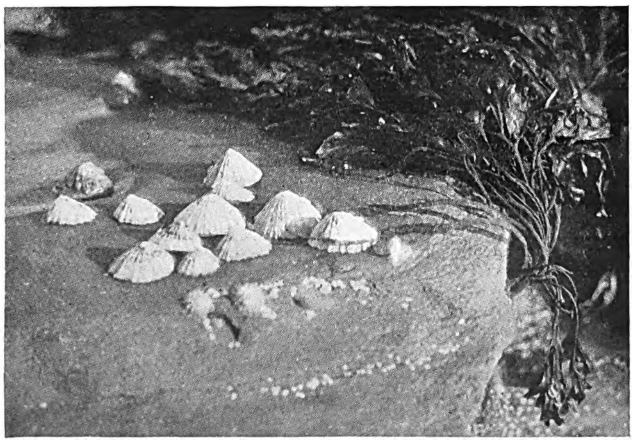
Here the story ends, but we cannot do otherwise than demand a sequel. Such a final deadlock as above described is not in accordance with the trend of thought initiated by Galileo and deepened by the investigations of every succeeding natural philosopher into belief in

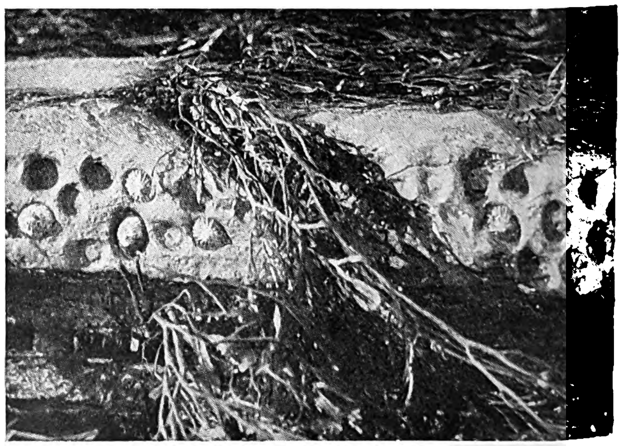
" . . . the perpetual round of strange,
Mysterious change."

If the old physics cannot solve the problem, and the new physics can go thus far and no farther, then we must wait hopefully for a yet newer natural philosophy to carry the final chapter on the chemistry of the stars beyond the *status quo* of the star molecule.

A Seashore Curiosity.

ALTHOUGH limpets, clinging tenaciously to the rocks like small pyramids of shell, are by no means an uncommon sight at the seashore, few people realize that the limpet is not quite so stolid and stationary in its habits as it would at first appear to be. Not only is it addicted to roaming about in search of food, returning usually to a fixed spot, but on certain parts of our coast, where it is in danger of being crushed by the large boulders churned up by the sea, it actually burrows into the rocks for safety. How long a limpet takes to make a burrow for itself, if any burrow can be taken to be the work of one solitary limpet, is a matter of conjecture ; but where the rock is of sandstone, it is no uncommon thing to find limpets embedded to a depth of quite half an inch, as the accompanying photographs show.





LIMPETS ON THE ROCKS AND (RIGHT) EMBEDDED IN SOFT SANDSTONE.

Athos : The Monuments of a Millennium.

By Robert Byron.

With special privileges for viewing its treasures, the author lately visited Athos, the Holy Mountain where for a thousand years the monks of the Greek Church have carried on their unique community. Fact and fable Mr. Byron elucidates at first hand.

THE Holy Mountain offers something of a challenge to the ordinary traveller. Access, provided its whereabouts on the map are familiar, is easy enough. The intending visitor must first reach Salonika, or, if he is coming from the east, Cavalla or Dedeagatch; and then, if he waits a day or two, a small steamer will eventually transport him in the space of twelve hours to the northernmost of the three fingers of the Chalcidice peninsular. Facing south-west, upon the inner shore of this woody ridge that winds like a forty-mile serpent through the silvery blue of the northern Aegean, lies the port of Daphni, a bight rather than a harbour and presenting no anchorage in rough weather. Great forested ramparts tower into the sky above the cluster of miniature buildings, a shop, two inns, and a warehouse like a cowshed, which denote the Liverpool of the Republic. And above them over to the right, risen 6,500 feet from the sea, rears the giant white cone in which the promontory ends.

Classic Renown.

It was the shadow of this, stretching seventy miles over the sea at sunset and dawn to the bewilderment of suddenly darkened islands, that brought renown to the Mountain in the pages of the classic writers. Then Christians annexed it, and added a more sophisticated lustre than natural phenomena alone could confer. This has remained, and, moreover, continues to shine with an intrinsic life which owes nothing to the feverish interference of antiquarians or artificial preservation societies. The traveller may focus on the past. But let him not forget that just as the Mountain fulfilled a need for the Byzantines, so it does also for the world of the Orthodox Church to-day. Temperamentally, East and West Europe are as far divorced as the cat from the dog. And there was a time, in the Middle Ages, when the civilization of the East was immeasurably the superior.

Meanwhile the ship is in, a gangway lowered, and a diminutive rowing boat bobbing up and down at its foot. On my first visit, I was in the position of the ordinary traveller; for I spoke no Greek, I was entirely ignorant of the elaborate manners and customs of the place, and the friend who was to act as cicerone had preceded me, and was waiting in the capital on the other side of the ridge. I recall still the waft of helpless apprehension that overcame me as I struggled with my bag down the stairs, and ultimately loosed my hold on the rational world of which the steamer was emblem. Slowly we rowed ashore; inexorably the steamer receded. Then all was bustle, for we must present our credentials to the government as soon as might be. The ride on mule-back to the top of the ridge, 2,000 feet up, lasted two hours. From there, a horizon of sea, risen halfway up the sky, appeared through the trees; and immediately below, set amid gardens and orchards, lay Caryes, the village-capital, where each of the twenty Ruling Monasteries keeps a representative to form the Parliament. Our friend met us, and he was a friend of that year's Protepistates, chief monk of the community and chairman of the Epistasia. To this body, an executive committee of four, we presented our letters of introduction from the Greek Foreign Office and the Metropolitan of Athens, and were furnished in return with a circular recommendation to the Ruling Monasteries, in the face of which none of them could refuse us hospitality. To accomplish all this, and then to claim that hospitality without the instrument of speech was almost impossible. The visitor must either have learnt Greek, possess a friend who has, or else assume the burden, both in expense and company, of a guide.

A Monastic Republic.

It doubtless arises in the mind of the reader that this talk of a monastic republic still flourishing on the sensible, utilitarian soil of Europe, is merely a technical fiction exploited by journalistic enterprise and invested with especial publicity value on account of its immemorial practice of excluding all females, both human and animal, from a luxuriant and ecstatically beautiful strip of the world's surface. In fact, this "female rule" is not the culminating monument to the fear of sex that is usually supposed. It was a simple means, conceived by Theodore of Studium, the monastic reformer of the ninth century, and borrowed by St. Athanasius of Athos a century later, of combating luxury; for without female

animals no meat or milk or eggs is produced; while the necessary beasts of burden have to be imported. Theodore's ordinance, it is true, was designed for a single monastery and St. Athanasius' after him. But in the eleventh century the trade in cattle evoked the complaint that Caryes was becoming a commercial town, and it was probably as a result of this that the rule was applied to the whole peninsular. This incident illustrates, moreover, the fundamental character of the Athonite community, which Western observers steadfastly refuse to recognize; namely, that in Eastern Christendom monasticism is not allied, as in Western, with learning and works of assistance, but is designed to promote, primarily, a mystical communion with the Universal God, and secondarily, an ideal social system. The monks to-day number five thousand; and in so large a community, scholars, workers of charity and rational thinkers are naturally to be found. But in essence everything is subordinated to contemplation and the elimination of competition. As aims, an obtuse and competitive world may term them selfish. But without necessarily affirming it, who shall deny that man's first duty is towards his inner peace? Modern civilization has chosen to identify that peace with "service." There are others, however, who disagree.

Early Hermits.

The Mountain was first invested with sanctity by hermits, of whom authentic records survive, and who were confirmed in their possession of it by a chrysobul from the Byzantine Emperor, Basil II Bulgaroctonos. This was in the ninth century; and it was in that century that Theodore of Studium, abbot of the monastery of St. John in Constantinople, sought to introduce a more coherent and communal form of living among the multitudinous solitaries of the Eastern Church. Imbued with the same ideal, Athanasius, a friend of the famous general and future Emperor Nicephorus Phocas, sought to found a regular monastery on the Mountain. Supported by his imperial patron both financially and morally—for the project did not lack opposition from the hermits, whose capital and framework of government were already situate at Caryes—he achieved his aim in A.D. 963. His foundation was known simply as the Lavra, in other words, the monastery; and there he lived till about the year 1000, when he was killed while helping to repair the dome of the church. His tomb may still be seen, together with an enormous cypress whose girth gives credence to the legend that he planted it. There survived also, till the beginning of the nineteenth century, the cell and library above the vestibule of the church, where he worked. These were then demolished owing to their precarious condition. But a picture of them, delineated in some detail on one of its piers, is extant in the model of the church that the Emperor Nicephorus is depicted holding in his hands after the manner of mediaeval benefactors.

"The Ruling Monastery."

Gradually, as the ensuing centuries progressed, other monasteries came into being on the Mountain through the generosity of the princes and prelates of the whole Orthodox Church. To these the scattered hermits were gradually, and at length definitely, subordinated, by order from Constantinople. Hence the expression "Ruling Monastery." For though there still exist many groups of monks living in separate cells perched about the precipitous cliffs, and even smaller communities dwelling in a common building, all the land and leases of the peninsular are the inalienable property of the twenty chief monasteries. The significance and value of this rule were only apparent in the nineteenth century.

In 1204 the Latin Chivalry of the Cross, led by Henry Dandolo, Doge of Venice, and Boniface of Montferrat, captured and sacked Constantinople. For sixty years the ancient Empire was parcelled out among upstart feudatories, and Athos, falling within the limits of the "Kingdom of Salonica," found herself under the plundering jurisdiction of a papal legate. The legends that survive of this period have grown rather than diminished in recent years. Thus, at the Bulgarian monastery of Zographou, the last century saw the erection of a stone cenotaph, in remembrance of the "twenty-six martyrs burnt by the Pope of Rome"; which was followed by a series of lurid frescoes depicting the pontiff's arrival in person to attend the immolation of the prisoners incarcerated in a tower. In reality these stories probably had their origin in the persecutions of the Emperor Michael I Palaeologus, who recaptured Constantinople and foresaw, two centuries before its actual fall, that only with assistance from the West could the Byzantines hope to retain it against the Turk. The price of that assistance was union with Rome. Hence the succession of futile concordats that now followed, resulting in minor coercions of the refractory, and culminating in the famous Council of Florence in 1438, where the attendance of the Emperor John V Palaeologus was immortalized by the brush of Benozzo Gozzoli, and the representatives of the Holy Mountain cast their weight against the union, conservative to the last.

It was, as a matter of fact, surprising that they should have been there at all, since the Mountain had already surrendered to the Turks in 1430, upon their capture of Salonica. This voluntary submission was to prove an important factor in the preservation of the community's independence. The Spaniard, Pero Tafur, who was travelling in the East about that time, reports that the grandfather of Mahommed the Conqueror had already attempted to capture the Mountain, but that the plague had fallen on his host as a result and that he had been obliged to repair all the damage that he had done, and even to increase the monastic endowments. It was perhaps the outcome of this event which ultimately enabled the Mountain to surrender on its own terms of administrative autonomy. To those terms the Turks faithfully adhered during the four hundred and eighty-two years of their rule. And thus it happened that while the Christian governments of Western Europe were denuding the monks of the last semblance of temporal power, in the East their position was maintained by the more sympathetic comprehension of the infidel.

With the fall of Constantinople in 1453 Byzantine history is at an end. For three centuries, beyond the account of an occasional traveller, there is little to tell of Athos. The government functioned, nominally supervised by a Turkish deputy-governor who was obliged to respect the famous edict and leave his wives behind. Old customs were maintained; new ones evolved. But gradually in the eighteenth century, when the Turkish decline after the last of the Kiuprili Viziers set in, it seemed that the Greeks must one day regain their lost empire. Wealth, learning, and industry were theirs. And their advancing prosperity was reflected on the Holy Mountain in the attempt to transform it into a place of learning, by the foundation of a school, above the monastery of Vatopedi, known as the Athonias. But the monks resented this lay encroachment, this attempt to provide them with a material *raison d'etre*. The headmaster was driven from the Mountain by calumnies, and the building was finally gutted by fire. To-day it remains, a pierced shell, monument to good intentions and warning against them. Then at length, outcome of the rise in the fortunes of the Greeks, came the Greek revolution, in which the hotter-headed of the monks implicated the Mountain and thereby subjected it to such ruinous penalties that only one thousand members of the community remained. But the fortunes of the monasteries rapidly revived. And the many fine buildings of the nineteenth century, from the church of St. Paul's dating from the 'twenties, to the astounding monastery of Simopetra which was not completed in its present form till 1894, bear witness not only to the material prosperity of Athos, but also to the continued vitality of Byzantine aesthetics.

Still the Mountain remained within the Ottoman dominions, and one last menace threatened its violation as the sanctuary of a vanished civilization. In the latter half of the nineteenth century, the Russians, by pouring novices and money into the community, made a determined attempt to obtain control of this independent political organism in the Aegean. They were frustrated in their efforts by the inalienability of monastic property referred to above, but their aggression had one important result. The autonomy of the Mountain was for the first time recognized in international treaty. Finally, after the Great War, by a clause in the Treaty of Sèvres, afterwards ratified at Lausanne, Greece bound herself to recognize the rights, valid through centuries of the foreign monasteries only. With regard to monks of her own nationality, their position was made impregnable by a guarantee included in the constitution of the state. In return, the monks deposited the code of laws and government of their own framing with the Greek Foreign Office; and voluntarily admitted Greek sovereignty on what the English, in common parlance, term a "dominion basis."

Correspondence.

IS THERE A SURPLUS MALE BIRD POPULATION?

To the Editor of DISCOVERY.

SIR,—Whatever else of value it may lead to, the letter from Mr. Philips Price in *Discovery* will have done good in emphasizing that ornithology must concentrate on the larger problems of population, rather than on those of the bird itself. One great difficulty in the interpretation of such facts as have been recorded by Mr. E. M. Nicholson, in your columns and in his books, on the examination of such statements as are put forward by Mr. Philips Price, arises from the physical inability of the few isolated investigators to cover more than a small portion of the whole field of avian phenomena. That in the future many workers in this interesting and promising field of endeavour will discard the Victorian method of bird study in favour of the new lines of research indicated by Mr. Nicholson cannot be doubted, and your help, Sir, in permitting so much of your valuable space to be devoted to the subject, must be greatly appreciated.

The suggested surplus of males in general is to me a new phenomenon, but if substantiated would not be surprising; much old knowledge is having to be revised in the light of the new ornithology. Latter-day observations, although far from complete, show that the problems of bird population are wide-ranging in their practical significance, and from whatever angle they are approached they seem to open up new avenues of investigation.

Yours, etc.,

HERBERT H. WARDLE.

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A Sidelight on the Geography of the Past.

By F. J. North, D.Sc., F.G.S.

Department of Geology, National Museum of Wales.

Research continues to shed new light on the manner of deposition of coal, the most valuable of our economic geological deposits. The author describes the results of some investigations which reveal the distribution of land and sea during the accumulation of the coal measures in South Wales.

RECENT research into the distribution of a certain rare mineral in the coal-bearing strata of South Wales has proved, as so often happens, that a particular line of investigation throws light upon matters quite unrelated to the problem in hand. It was hoped to discover whether the mineral was more particularly associated with some coal seams than with others, but although the evidence proved inconclusive upon that score, it was found to have a bearing upon the wider problems relating to the geographical conditions at the time when the coal-bearing strata were being deposited.

Millerite was the mineral under investigation. This consists of sulphide of nickel, and crystallizes as slender needle-like crystals, brassy yellow in colour, and with a bright metallic lustre. In South Wales it occurs as radiating groups or tufts of crystals, together with other minerals, in cavities which are associated with cracks in the bun-shaped masses of ironstone that occur in the shales of the coal-bearing strata or Coal Measures (Fig. 1). The nodules (or concretions) of ironstone owe their origin to the local segregation within the Coal Measures (when they were accumulating as muddy swamp-deposits) of carbonate of iron and other compounds, and they owe their present characters to the fact that crystallization set up in what subsequently became the outer layers of the nodules. During the process of crystallization a substance decreases in volume, and in the case of the nodules of ironstone the result of the crystallization was that the material remaining inside the layer already crystallized was not sufficient, when *it* also had passed into the crystalline condition, to fill all the space available for it, and cracks were developed. These cracks were usually arranged according to a definite plan, some of them being concentric; those near the centre being arranged so as to divide the material into polygonal columns (see Fig. 1). Mineralized waters mingled in the space thus provided and, interacting, deposited their dissolved salts in the form of crystals lining the walls of the cracks, or even filled them. Among the most abundant of these minerals were calcite (carbonate of calcium, or carbonate of lime) and quartz, but associated with them in small quantities were the sulphides of certain metals such as nickel, lead, zinc, copper, and cobalt. Of these sulphides, the first was, on the whole, the most widespread, and the last the least abundant. It is with these two alone (the minerals *millerite*, sulphide of nickel, and *linnaeite*, sulphide of cobalt) that the remainder of this paper deals.

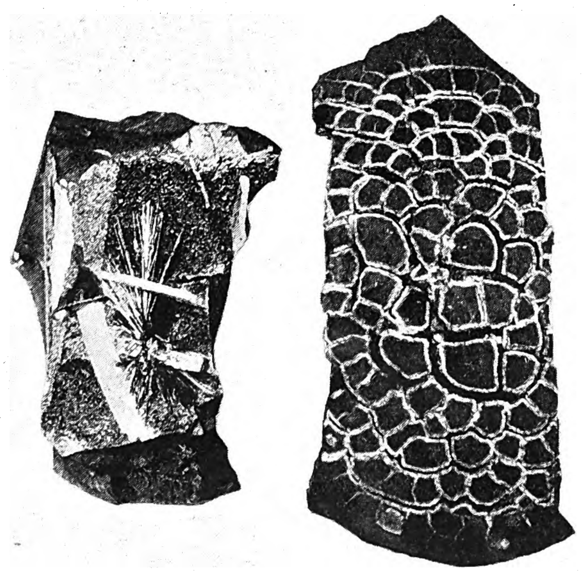


FIG. 1.
FROM THE SOUTH WALES COAL MEASURES.
Left.—A tuft of Millerite crystals from an ironstone nodule (natural size). Right.—Part of an ironstone concretion showing Millerite (one-fourth natural size).

After exhaustive inquiries, specimens of millerite were found to occur in fifteen localities in the South Wales Coalfield, at some of which linnaeite also occurred. Although the ironstone nodules that contained millerite were more abundant in association with some seams than with others, the records were not enough to justify the drawing of definite

conclusions upon the matter. Hence as far as its original object is concerned the investigation may be regarded as abortive. The question naturally arose: from whence came the nickel necessary to account for the presence of crystals of millerite in relative abundance (that is, for so rare a component of the earth's crust as a whole) distributed over a wide area in the eastern portion of the South Wales Coalfield? (Fig. 2). Since nickel and cobalt are almost invariably associated, the nickel (except in local ore masses) being the more abundant of the two, their origin in this connexion is undoubtedly intimately connected.

Information Wanted.

Unfortunately, very little is known concerning the distribution of nickel and cobalt as constituents of the earth's crust, beyond the fact that they occur in extremely small quantities in igneous rocks,* whilst they do not appear to be present at all in most sedimentary rocks.

The average of many analyses of igneous rocks shows that nickel is present to the extent of nearly 0.03 per cent; copper, lead, and zinc are present in very much smaller quantities. This is of interest in view of the much wider distribution of the ores of lead and copper than those of nickel, and is probably explained by the fact that the two first-named metals are more susceptible than nickel to the processes by which metallic compounds have been segregated in sufficient quantities to be exploited as ores.

The only igneous rocks in which nickel and cobalt occur in more than mere traces are those which are rich in iron-and-magnesium-bearing minerals, and which are poor in silica (such as the rock called *peridotite*, and *serpentine* which results from alteration). Such rocks are always associated with the deeper layers of the earth's crust, and, therefore, are only exposed at the surface in regions where there has been extensive denudation, as the wearing away of the earth's surface by atmospheric agents (such as rain, wind and frost) is called.

The reason for the occurrence of these rocks in the deeper layers of the earth's crust is that, during the early stages of its development, the superficial layers must have been in a molten condition. It is improbable that the same applies, as was formerly supposed, to the great bulk of the earth's interior, which from its density, its transmission of earthquake shocks, and from the suggestive evidence provided by meteorites, is believed to consist essentially of nickeliferous iron. When the superficial layers of stony material were molten, there was a tendency towards differentiation under the influence of gravity, the heavier material sinking and the lighter rising, so that the primitive crust of the earth may be thought of as consisting of concentric, but not sharply separated layers. The uppermost layers contained the lightest material—rocks rich in silica and corresponding in composition to the so-called "acid" igneous rocks, such as granite; whilst the lowest layers consisted of heavier material corresponding in composition to the more basic (that is, with less silica) igneous rocks. Between them were other layers of intermediate composition.

From their original deep-seated situation the peridotites and allied rocks would be more likely than any of the others to receive additions from the deep-seated metallic core, and thus come to contain traces of nickel and cobalt. Further, they would be less likely than the overlying material to penetrate the upper layers of the earth's crust, or to reach the surface during volcanic episodes, so that they would only be exposed as a result of the denudation of material that originally rested upon them.

These considerations were taken into account when attempting to explain the presence of the nickel and the cobalt in the sediments of the South Wales Coalfield, and it soon became apparent that although the investigation had for the moment failed in its original object, it was destined to throw light upon another problem altogether.

Land and Water.

It has long been realized that the study of rocks and their arrangement throws light upon the geographical conditions of the past; for example, if a bed of sandstone is found to pass in a certain direction into coarse pebbly rock (conglomerate), just as the sand along the sea coast often passes into a beach of pebbles, it is obvious what the pebble beds indicate. At the time of their formation, the place where they now occur must have been near the shore of the area of deposition, from which it is legitimate to assume that the original limits of the stratum have been reached, or are not far distant.

This indication of the way in which rocks yield evidence concerning their original extension, will illustrate the fact that when sufficient information is available it is possible to indicate approximately the distribution of land and water at the time of the accumulation of any particular group of rocks.

The evidence is very varied in its character, and sometimes comes from unexpected sources; for

* Igneous rocks are those which, like granite, were originally in a molten condition, and sedimentary rocks are those which, like sandstone, were laid down as sediments by a water action.

example, the distribution of millerite in South Wales throws light upon the geography of the later part of the carboniferous or coal-forming period.

In the British area the earlier geological periods were times of more or less continuous subsidence, because many thousands of feet of strata were deposited beneath the sea during the Cambrian, Ordovician, and Silurian periods. These rocks, which are extensively developed in Wales and the west of England, form the floor upon which rest the newer rocks of the midland and eastern counties. It is obvious that the accumulation in an ocean basin of a vast amount of sediment implies an equally vast denudation of the neighbouring land areas from which the sediment was derived.

The tendency of the natural processes that are shaping the surface of the land, by removing material and ultimately depositing it upon the sea floor, is gradually to level off the continental masses and to fill up the ocean basins. Therefore, if the denuding and depositing processes continue in any one region for a very long time without any appreciable changes of external conditions, the result would be to produce an extensive land area not much raised above sea level, passing into shallow mud-laden swamps.

This condition was reached in North-western Europe towards the end of the great marine episode of the Palaeozoic era. The peculiar feature of Coal Measure time was that after a long period of denudation and deposition, those two processes were more evenly balanced than at any other time, with the result that the expanse of low-lying land near sea level and of shallow sediment-choked coastal waters, was unusually great, and the physiographical conditions were practically uniform over wide areas and for a long time. To this effect is due the wide extent of the coal seams of north-western Europe.

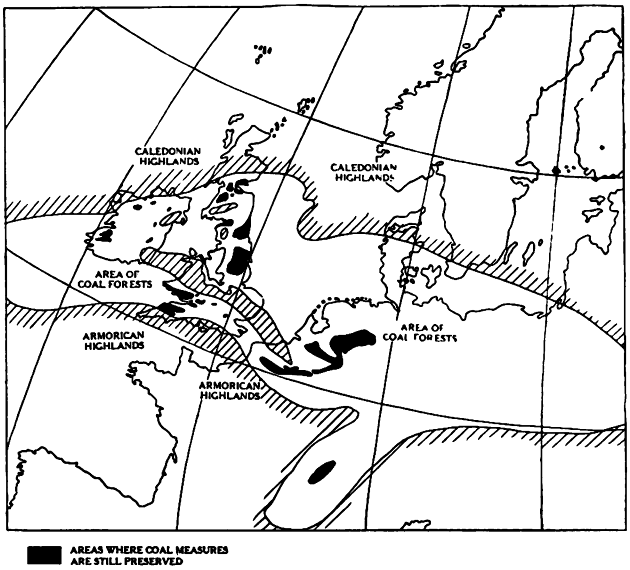


Fig. 3.

ORIGINAL EXTENT OF EUROPEAN COAL FORESTS.

Although deposited over a wide area the coal measures have escaped denudation only in the areas coloured black.

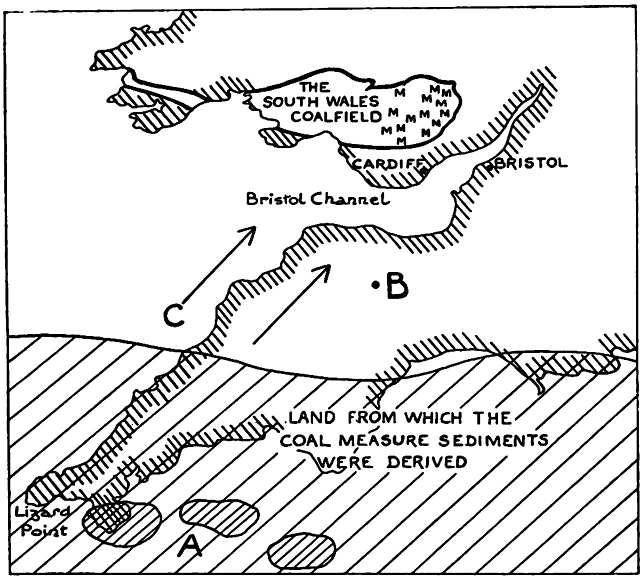


Fig. 2.

MAP OF THE COAL MEASURE PERIOD.

A.—Areas of igneous rocks (containing nickel and cobalt) exposed by prolonged denudation in late Carboniferous time. B.—Locality near Tiverton where nickel and cobalt occurs in the coal measures. C.—Locality from which material of coal measures was derived. M.—Localities where Millerite occurs in the coal measures.

Such prolonged denudation must have resulted in the exposure, locally, of the lower layers of the earth's crust, and we may safely assume that during Coal Measure times, extensive areas of rocks that are usually deeply buried had been exposed, and were undergoing denudation.

At the present time, as we have seen, nickel and cobalt occur in association with certain kinds of igneous rock, or their altered products, that are found in regions where very old rocks have been exposed by the removal of the overlying strata. If an area of such rocks were undergoing denudation in Coal Measure times, and furnished some of the material for the South Wales Coal Measures, it is not unreasonable to look to that area as the source of the metals that gave rise to millerite and linnaeite. This suggestion is by no means without supporting evidence. Taken as a whole, the Coal Measures of South Wales tend to thicken in a south-westerly direction, and this, together with the evidence of current-action in some of the strata, suggests that the material was derived from the south-west. A similar conclusion was arrived at by Dr. A. Heard, as a result of an examination of the heavy minerals present in certain of the sandstones.

Now, in the Lizard district of Cornwall there is a mass of very ancient rocks, including several varieties of serpentine, all of which contain nickel and cobalt in association with iron ores. Although the area now occupied by these rocks is small, most of its margin is determined by the sea, and it may represent only part of a much larger mass, or one of numerous masses that may have existed in the land region, which, when the Coal Measures were accumulating, occupied the site of the South of England, the English Channel, and Brittany. It was on this land-mass that earth movements, towards the close of the Coal Forest period, resulted in the elevation of mountain ranges called by geologists the Armorican Highlands, after the Armorici, a tribe that once inhabited Brittany (see Fig. 3).

If, therefore, a land-mass to the south and south-west provided at least part, if not all, of the inorganic material of the South Wales Coal Measures, and if in that land-mass there were areas of nickel-bearing and cobalt-bearing rocks undergoing denudation (and it should be borne in mind that owing to the peculiar conditions of the time, to which reference has already been made, larger areas of such rocks may then have been exposed than are now to be seen), we have an explanation of the source of the nickel and the cobalt in the Coal Measures (Fig. 2). In this connexion it is interesting to record that the two metals have been found in association in rocks of similar age at Hockworthy, north-east of Tiverton, which lies between the region of the Armorican Highlands and the South Wales Coalfield. Thus, while the general character of the deposits indicates that during the coal-forming period land existed to the south of the British area, the presence of the mineral *millerite* in the ironstone nodules of the South Wales Coalfield throws light upon the nature of that land. It suggests a country in which mountain masses had been raised during periods of earth movement, and the surface of which had, by Coal Measure time, been so lowered by denudation that the mountains had been worn to mere stumps, and the old, once deeply buried rocks of their innermost cores exposed. Towards the close of Coal Measure times the earth movements were resumed, because high mountains were again raised on this ancient land.

Is there a Surplus Male Bird Population?

By E. M. Nicholson.

Author of "How Birds Live."

Recently a correspondent described new observations which led him, arising from Mr. Nicholson's book, to postulate a surplus male bird population. Mr. Nicholson was away at the time in the capacity of ornithologist with the Oxford Expedition to Greenland, and in reply he now suggests by what means observers might co-operate to discover an adequate answer to this question.

THE question whether the bird population contains a surplus of males, which was raised by Mr. Philips Price in the August issue of *Discovery*, certainly deserves more attention than it has so far had. Unlike many ornithological problems it seems capable of fairly rapid solution by straightforward methods of observation. The reason why so little is known about it is simply that so little has been looked for. Ornithologists have been concerned with matters which seemed to them more important, which I will resist the temptation to specify.

Unfortunately, the question of the surplus males cannot be disentangled from the general problem of organization during the breeding season. The best proof of this is Mr. Philips Price's letter, which, in spite of the care he has taken over stating his case, assumes throughout that a non-breeding population postulates a surplus of one sex—in his opinion the male. But there are three necessary conditions before breeding can take place; it requires the conjunction of an adult male, an adult female, and a suitable territory furnishing both food and a site for the nest. Theoretically, then, breeding might be frustrated in more than one way; the male, for instance, might secure a mate but not a territory. In practice it seems to be the rule (although exceptions undoubtedly occur) that the male must find his territory before he can think of mating, which explains why the male warblers on their way north in spring outstrip the females just when it seems most desirable that they should be together, and arriving in England a few days earlier hasten to seize a territory before turning their attention to a mate. Having these two conditions to satisfy they seem deliberately to put territory first and let the mate look after herself. This is curious because, while it would be simple enough for a pair to go house-hunting together, the single cock, once he has secured his territory, is tied down to it, and

unless a mate comes along of her own accord he is left in the lurch. And that does actually happen; wood-wrens and tree-pipits, for instance, will arrive and sing three weeks or so at the chosen spot, and if they fail to mate will abandon it at the eleventh hour in favour of some other quarters.

The Forlorn Female.

Now this system by which the male finds the territory and the female finds the male must obviously exact a good deal from the hens. Aided by the songs and conspicuous actions of the territorial cocks, they have to find eligible mates in a very short space over a great extent of country. To provide mates within three weeks or so for all the cock willow-wrens from Dover to Stornoway is a formidable proposition, and it would hardly be surprising if on a closer scrutiny the machinery of distribution turned out not to work perfectly, so that one region had a local surplus of cocks and another of hens. Therefore, before we jump to the conclusion that the cocks outnumber the hens, we must have very detailed and accurate information from a large number of representative localities. Quite possibly it may be found that some have a large population of mateless cocks, others of mateless hens, and others of non-breeding adults of either sex, who are either not sexually developed at the time or are excluded by shortage of territory. There is a further possibility, often realized in the Arctic, that a cock after securing both territory and a mate may be frustrated from breeding by unfavourable weather conditions, but this is really a case where the requirement of *suitable* territory has not been fulfilled so far as that season is concerned.

As the territorial system requires the cock to make himself conspicuous in every possible way, it is clear that anything leading to large numbers of both sexes remaining mateless would appear as a surplus of cocks; the single hens, though they might be more numerous, would remain in the background and ordinarily would be hard to discover. In fact, even the most careful census will not give a satisfactory figure for unmated hens, although it may indicate their existence, as some of my censuses have done. The readiness with which birds of either sex, and of comparatively rare species, replace a mate lost during the breeding season seems to indicate a large and mobile non-breeding population always ready to step into gaps, and the best, if not the only, way of getting evidence on this seems to be the non-humanitarian one of catching the hen or cock at selected nests and seeing how often the operation can be repeated. This might be done with starlings or great titmice, for example—to name two common and easily taken forms whose sexes are distinguishable in the hand—and the value of the data would certainly outweigh the inconvenience to the birds.

Should it prove possible, as is alleged, to catch hen after hen on the same nest and to repeat the process in various parts of the country, the theory of a surplus male population will begin to look untenable. If Mr. Philips Price is willing to try this experiment in Gloucestershire next spring, I will see what can be done about it at Oxford, and perhaps some other observers elsewhere may come forward to co-operate. The results ought to give some indication of the real state of affairs. If the kidnapped hen proves irreplaceable a case for the surplus male theory will have been made out, and kidnapping a series of cocks will put it further to the test. No doubt an interesting situation will arise when all the kidnapped mates are let out. Watson and Lashley, when they experimented with the homing ability of noddy and sooty terns on the Tortugas, discovered that a husband returning after a long odyssey was liable to find himself replaced, and to be hustled ignominiously off his former territory by a successor who did not know him from Adam.

Victims of Economics.

Without having much evidence to go on my present impression is that the non-breeding bird is generally a victim of economics rather than of an unequal sex ratio, although the fact that many cocks—white-throats, for instance—first secure a mate very late in the season seems to suggest that faulty distribution may cause local disparities between the sexes which may not be rectified in time. In Greenland last June with the Oxford Expedition I could find no non-breeding population among the small passerines, and the only indication of an unequal sex ratio among land birds was an occasional case of bigamy in the ptarmigan. I put this down to the fact that the severe winter and the perilous migration required to avoid it leaves a population out of all proportion to the immense summer food resources, so that there is territory for all comers. The more open and uniform nature of the country, and the fact that it forms such a narrow ribbon round an uninhabitable ice-cap, no doubt make perfect distribution easier. It appears to me that anything like a standing surplus of cocks must strike at the roots of the territorial system by making the hens instead of territory the main object of rivalry. In fact, it would tend to reduce all birds to the condition of the ruff, in which (as Edmund Selous has shown in his masterly "Realities of Bird Life") many cocks gather at one hill to compete for

the favour of the reeve, who chooses by her own will or caprice, over-riding all other considerations. I see no trace of any such power among the hens of normal territorial species, and therefore I believe that the hens cannot be numerically in such a favourable position as Mr. Philips Price seems to think. When he suggests that the frequent celibacy of his Gloucestershire nightingales may be due to their being on the fringe of the range, I am inclined to agree with him, although the nightingale does certainly breed in the Wye Valley and parts of South Wales.

It is recorded in the July number of *British Birds* that a similar bachelor nightingale has appeared and sung for a few days "almost every spring for the last five-and-twenty years," in the Aune (Avon) Valley in Devon, far west of the traditional limit of the range. But if we accept this explanation in the case of the nightingale, it clearly cannot apply to the chiffchaff and willow-wren, among which Mr. Philips Price suspects a similar state of affairs, for both these extend north into Scotland and west beyond the Irish Sea, and we still have to fall back on uneven distribution or inequality of the sexes. It would be interesting to learn what methods he has discovered of distinguishing the sexes of great skuas in the field—a thing which so far as I know no other ornithologist has hitherto succeeded in doing. While the evidence that the party met with were unmated birds seems fairly convincing, we have no evidence at all that they were males, which is the point at issue. The presence of unmated birds of either sex is, of course, a familiar feature, especially in the north, where summering turnstone, purple sand-pipers, and many duck have often raised false hopes of additions to the list of British breeding species. The red-necked phalarope, the other species which Mr. Philips Price has cited, is hardly a legitimate example; its breeding habits, with the females dominant, are scarcely less abnormal than the cuckoo's, and like that bird's are quite probably connected with a heavy surplus of males.

Scope for Observers.

But in criticizing some details of Mr. Philips Price's argument, I am not suggesting that his letter is not an interesting contribution, which may be valuable in drawing attention to a matter which, as he says, has so far received too little. There are scraps of evidence from many regions suggesting that his view may be at least partly right, although I do not share it myself. Thus Wetmore in South America during a recent breeding season noted "Flocks . . . composed mainly of males that were not breeding, some in a condition of partial moult of the body plumage" in the case of the crested tinamou; and on 8th November, 1920, between 5 a.m. and noon, he saw 15-20,000 pintails (*D. spinicauda*) of which over 95 per cent were males, which had either not bred or had deserted their mates and migrated during the breeding season. In this country many counts of duck have brought out a disproportion between the sexes, but as they either do not refer to the breeding season, or cannot take account of sitting females, they only indicate what is seen and cannot prove an actual disparity. There are, however, many common birds whose sexes are clearly distinguishable, which are admirably fitted for intensive study, and if a few observers would turn their attention to the subject there is no reason why it should remain in such an unsatisfactory state much longer.

Lecture Demonstrations.

A PRIVATE demonstration has been afforded to *Discovery* by Messrs. Sands Hunter of a new epidiascope, the "Zeiss-Ikon," which constitutes a marked improvement on previous models of projection apparatus. Three methods of projection are provided for, as in addition to its use for prints and other opaque objects, and lantern slides, there is a microscopic slide attachment. The arrangement is such that a print and a lantern slide may be placed in the instrument at the same time, and by merely turning a lever one or other can be shown on the screen at will. The advantage of this to school lecturers is obvious, for crystals, mechanical apparatus, or a small scale experiment can be shown at one instant, and the underlying principles illustrated a moment later by the projection of a lantern slide diagram. For convenience in demonstrating, provision is made for the insertion of a pointer into the body of the instrument, and thereby attention can be drawn to particular details.

While the lantern slide holder is built into the instrument, it is necessary to use an attachment for the microscope slides. This is inserted in place of the lantern slide lens, and a valuable detail in this connexion is the provision of a heat filter to prevent the possibility of damage to the slides from the heat of the lamp. The advantage of this attachment is, of course, that a considerably magnified image of the microscopic slide can be thrown on the screen and seen by the whole audience or class at once, thus saving the great amount of time which has to be spent if each member is to see the slide in the microscope.

The shape of the epidiascope is not unlike a coal box placed on its side, and instead of the previous exterior ventilator, the top in the new model is neatly perforated like the radiator of a motor-car engine.

A Holiday in Search of Salt.

By Hugh Nicol, M.Sc.

Humorous adventures were met with in Austria during a fortnight's holiday which included the business of seeking a specimen of transparent rock-salt. The author travelled about 2,500 miles before he met with success, in following up a trail to which he had only a postcard clue.

NEEDING pure clear crystalline salt for a scientific purpose, and having found that the quality I required was not obtainable in sufficient quantity in Great Britain, I wrote to the propaganda department of the Austrian State Railways to ask them where in Austria I might hope to find what I needed. Nearly a fortnight passed, and the first day of my holiday had arrived without any answer, when I received a letter from Austria just before leaving by the night train. The Austrian railways, I learned, had been good enough to get into touch with the Austrian Salt Union, whose address was given as " Porzellang." Evidently I had to find " Porzellang," although I owned no more details of Austrian geography than I had been able to gather from the travel literature.

THE STASSFURT SALT MINES.

A mechanical conveyor is here seen loading with white salt. The absence of props or other roof supports may be noted.

I looked forward to the journey, feeling that a pleasant holiday awaited me even if I could not obtain what the famous Tyndall—who incidentally had help from influence and acquaintances to which I could not pretend—called categorically " this precious substance." The English Salt Union had already given me several pieces of their museum specimens, at the same time informing me that the British salt, in the form in which I required it, was not so suitable as that from the famous mines of Wieliczka in Poland. But Poland is distant ; and had not Austrian salt contributed to the place-names of the country ?—Salzburg, and the Salzkammergut, were suggestive. Hall and Bad Ischl were famous for their salt-mines, and I had noticed several places of which the names ended in *-ang*, but I could not find Porzellang ; probably it was an industrial centre not worth mentioning in a tourists' booklet.

Innsbruck is only a few miles from Hall, and, having arrived at the western end of Austria, I felt that the quest had really begun. Changing some money at the station bureau, I asked for help in finding " Porzellang," showing the postcard. My German was not good enough to explain the place-name analogy which had misled me—but " Porzellang." meant *Porzellangasse* in Vienna ! It is, of course, common to use *g* as a contraction for *Gasse* (street), and if any indication had been given that the address was Viennese, I should have had no difficulty in recognizing it ; Vienna, however, had not been mentioned. Now, Vienna was some four hundred miles further on, and in some doubt as to what course to pursue, I decided to try my luck at some of the mines *en route*, starting with that at Hall, which is the largest in the country. This proved useless, for what I wanted was not the ordinary salt turned out by the thousand tons, but the clear variety called by the French *sel gemme*, and very scarce it is. Taking the train towards the Salzkammergut group of mines, which were for long in the jealous possession of the princely bishops of Salzburg, I next visited the mine at Dürrnberg, near Hallein, which has been worked since prehistoric times.

This mine lies entirely within a hill, and for that reason no vertical shafts are needed ; access to the workings is obtained by nearly horizontal tunnels which open quite inconspicuously in the wooded mountain side. Some are lined with masonry, some are hewn in the rock, and some are heavily propped with timber. The main entrance is at the top, and after a gruelling climb, visitors are glad to take a rest while waiting for the guide ; to both sexes overalls are given, and the donning of these fancy-dress costumes, which bear little resemblance to the dress of the actual workers, is not the least impressive part

of the visit. There is a leather apron worn behind and a leather grip for the right hand. The ladies have to be equipped for riding astride. The guides take acetylene lamps, and conduct the party to the back of the offices, where a narrow passage, looking exactly like a cellar entrance, leads into the recesses of the ancient mine.

For some distance we proceed in single file, queerly conscious of being underneath the marble church which was so conspicuous on the hillside we have just left, and then the guide shows us the first traces of salt in the unfruitful rock, traces so small that unaided we should never have found them. With quickened interest we walk on, to a branching of the ways, where menacing passages stretch into the unknown dark; they are not our ways, and are not lit. A little further, and we see evidence of the need for care—ancient timbers crushed and splintered, and fragments of leather, half fossilized, are incorporated into the rock itself. Even more grim seems the narrow slit where hardly a cat might enter, which marks a tunnel wherein men once worked, now slowly but irrevocably closing under the swelling influence of atmospheric moisture that has been let into the interior of the mountain by the way we have come. In a wider space, where there is another level road, and a tunnel sloping steeply down into darkness, the guide halts, and waits for the tail of the file; he stands at the head of the descending passage. Except for the shiny wooden beams on its sharply inclined floor, it might be one of those funnels by which Jules Vernes' travellers went into the depths of the volcano. Where do we go now? The other road is not lit: the guide sits down on the brink—we are to slide behind him into the depths!

A Dizzy Descent.

At the bottom we release our leather grip from the friendly brake-rope, which has not prevented us from attaining a dizzy speed, and stand up. Like everyone else who has been presented with this initially hair-raising experience, we ask if there are any more *Rollen* to come. We are grateful to hear that there are no fewer than five more, and we walk steadily on for a dull five minutes wondering when the next Rolle will announce itself; some of our attention, however, is given to the specimens in the museum in the heart of the mountain, and to the lighted model scene of the legendary gnomes who used to dig for salt until they were frightened away for ever by the first stroke of the bell of the first church in Dürrnberg. We cross the frontier into Germany, and come back again—no tiresome *Passkontrolle* or customs here! Then through a shaft we are given a peep at the lake a hundred and fifty feet below, and after two long glides we reach this Midland Sea, almost expecting to hear prehistoric beasts crashing through the (non-existent) undergrowth. However, we are ferried across in dead silence, and marvel at the vast underneath of the mountain unsupported above our heads. It is interesting to note that in these sunless regions the roof of the brine-lake caverns is called *Himmel* (sky) by the miners. Finally, we glide out astride a trolley again into daylight, to the absence of which we have become almost accustomed in the past hour.

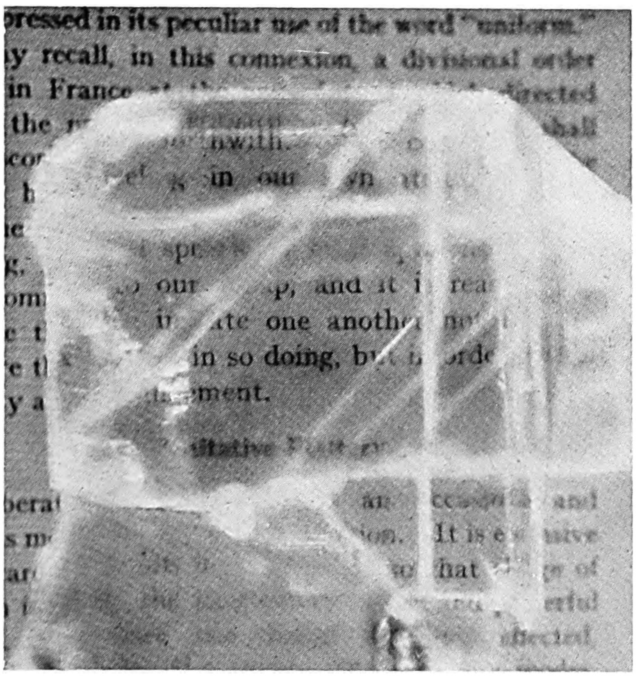
The Quest Fulfilled.

Beforehand, while waiting for a party to assemble, I had got into conversation with Herr Ressel, who showed great interest and held out hope of a suitable piece of salt being obtainable later, if I would come back after going down the mine. Whether this was a test of sincerity of purpose I know not, but I made that climb again; my friend was not there, and I was on the way down for the last time when somebody came running after me with a piece of clear rock-salt—the only piece of salt I obtained from Austria. At this point I may record that upon my return to England I found a very friendly letter from the Austrian Salt Union, offering every facility, but saying that—like the English Union—they could only refer me to Wieliczka, as no clear salt was to be found in present-day Austria. Here, then, was an interesting example of persistence of error, long after political boundaries had altered. Though I am not sure of the exact pre-war delimitations, I know now that clear rock-salt is scarcer in Austria than it is in Cheshire.

My next visit was to the mine at Berchtesgaden, across the German frontier. Berchtesgaden is a lovely spot, insufficiently known by British holiday-makers. The mine possesses a large, irregularly-shaped cavern about sixty feet high, formed by the removal of impure salt; the walls are entirely composed of grey salt. It should be realized that this cavern is not a spectacle of dazzling whiteness, nor does it resemble the elaborately-sculptured halls of Wieliczka. A few show-pieces of simple design, worked in crude salt, are the only ornaments of the rock-like chamber, from which descends the only long *Rolle* that the mine contains. This one, however, is more dizzy than those of Dürrnberg and there is no brake. It took me an appreciable time to collect my thoughts at the bottom! The mine has the unexpected luxury of a comfortable electric lift, for visitors only; by this

detail, with fanciful illumination and the apparent absence of workers or signs of work, one is led to think that the visitors' "traffic" is the mainstay of the mine. Nevertheless, work unseen is proceeding insidiously, brine passing out by a couple of small pipes which seem ridiculously inadequate to represent the product of hundreds of years of excavation of miles of passages—for long distances through hard rock—or to feed the huge evaporating works in the distant valleys below.

When I inquired at the Berchtesgaden mine office there was not a single piece of clear salt of any kind, but an official recommended me to go either to the famous potash mines at Stassfurt, or else to an address which he wrote down as Hildesia Mine, near Magdeburg, some five hundred miles away. It looked, as the Americans say, "a proposition," since if Magdeburg drew blank, I should be near Stassfurt. I arrived in Magdeburg in the small hours, and was obliged to spend the rest of the night in a wretched hotel such as I should not have thought Germany possessed; its unappetizing breakfast was all I had to eat till late in the evening of an exhausting and unsatisfactory day, lightened only by the truly extraordinary kindness of a local policeman. Herr Mallnitz found time to take me to the offices of a Magdeburg newspaper in a painstaking but unsuccessful effort to trace the vague address brought from Berchtesgaden.



THE AUTHOR'S QUEST.

Part of a page of *Discovery* photographed through a piece of unpolished Stassfurt rock-salt, an inch and a half thick, through which the print can be clearly read. Difficulties of refraction prevent the whole from being in focus at once.

THE "ROLLE" AT DÜRRNBERG.

Entrance to the Dürrnberg salt mine is made by polished wooden beams—the *Rolle*—on which visitors, dressed in special white overclothes, slide into the depths. The hand rope provides the only brake.

Proceeding to Stassfurt as a last hope, knowing nobody in the town, I walked about ten miles in an effort to find the offices of the mines. I passed the offices without knowing it, and when I had discovered the mistake, it was too late to do anything more that night. Next morning I was received with great kindness at the offices of one of the mine groups by Herr Knöppler, who sent a man into the mine with special instructions to look for the salt I required. He also gave me a letter of introduction to his friend Herr Reimann, who, he knew, had some picked specimens. I became indebted to both these gentlemen for pieces of great purity. Incidentally, they had no difficulty in finding the address of Hildesia, but it was in Hanover, two hundred miles away; it was reassuring to find that I had not been a victim of a hoax. I met with like efficiency, and readiness to please a stranger, in the Anhalt mines on the other side of Stassfurt. Upon the fields adjoining the factories abundant crops were raised; they extended literally up to the walls of the factories, and all around, but with no sign of damage to vegetation from the fumes of the noxious processes carried on within. The earlier annoyances and strange contrasts made the day one of the queerest I have ever spent, but I had seen the perfect thoroughness of the German chemical industry.

Papers at the British Association Meeting.

(By Our Special Correspondent.)

A record attendance was obtained last month at Glasgow by the British Association. As the printed proceedings fill a substantial volume, our report is confined to a few outstanding papers, with some general impressions of the meeting.

EACH annual meeting of the British Association has its own distinctive characteristic; and to this rule the gathering at Glasgow from 5th to 12th September was no exception. Perhaps owing to the size of the town and the numbers of the population the British Association badge was less noticeable in the streets than on other occasions, while the distance of the University, where the meetings were held, from the centre of the city tended to confine the members to one area, with the advantage that they remained more closely in touch. In consequence, the sessions of the various sections were more fully and constantly attended than is sometimes the case. In recent years the numbers at the meetings have tended to increase—a hopeful sign of the rising interest in science. The Glasgow meeting was large, indeed well above the average, and passed the three thousand mark.

A meeting of the British Association has a twofold audience. It is addressed in the first place to the scientific world and general public at large; but its proceedings must also have in view local problems and local needs. Nor must it be forgotten that the visitors have an exceptional opportunity of learning from those who know at first hand the conditions, problems, and resources of the locality in which the meeting is held. That Glasgow and Scotland had much of interest to impart was to be gathered from the sectional programmes, particularly in Agriculture, Forestry, Education, Geography, and Anthropology.

Though it may appear invidious to select when so much was excellent, mention must be made of Sir George Macdonald's Presidential Address to the Anthropological Section on the Archaeology of Scotland, in which the interest of the subject matter was enhanced by consummate artistic delivery; Professor Bryce's stimulating discussion of Human Distributions in Scotland; and the skilfully grouped series of illuminating papers on the geographical factors at Glasgow.

The concentrated attention with which the audience followed the address of the President, Sir William Bragg, was perhaps no more than was due to the importance of the occasion and the interest of the subject, presented in a masterly manner. But it was a feature to be marked at the evening discourses and most of the meetings of the sections. Like the increase in the number of members, it may perhaps be taken as an index of the extent to which science is beginning to take a grip of a wider circle of the public as a live interest, and no longer regarded as a closed book to all but a few who are in but not of this world.

Science and Craftsmanship.

Sir William Bragg ably surveyed the relations of Science to Craftsmanship in its truest and broadest sense. His theme may be summed up in one of the original statements of the purposes of the Association, which he quoted: "To obtain more general attention for the objects of Science." His definition of craftsmanship was "the skill which is exercised in the production of whatever is wanted for human welfare." Craftsmanship has a value in itself, being the result of the natural desire of men to use what faculties they possess. In its widest sense it not only represents a nation's efforts to live—it is its very life. From the craftsmanship which gave the world the vase of Ancient Greece and the Roman arch has evolved the modern craftsmanship with its dependence on machinery and with its wealth of production.

This evolution is the result of the individual's wish to better his material condition and that of his neighbour. It could not have been prevented, and with all its noise and ugliness we must recognize the plain truth that modern craftsmanship supplies the necessities of life to millions who would otherwise die. The urgent drive of self-preservation has forced the craftsman, time and again, to call in science to his aid. Sometimes the call and reply has been prompt and effective, as when the dwindling coal industry was saved by the discovery of the steam engine; at other times the application of scientific knowledge has been slower, as in the case of the Clyde shipyards. In the latter case the growth of science and craftsmanship has been simultaneous, through the co-operation of laboratory and factory. For the greatest prosperity this must be so, as is

evidenced by the remarkable fact that the most active of our modern industries are those which have been founded on recent scientific research—especially the electrical engineering, dye, motor, rubber, and the chemical industries. Compared to these modern industries we have the spectacle of serious depression in the pre-eminent industrial trades of coal, steel, wool, and cotton.

According to Sir William Bragg there are two reasons for this depression. The first is that, although the means for improvement, the intelligence, skill, and other qualities of our craftsmen, are present to a remarkable degree, they are not made use of by the contact of scientific knowledge and industrial experience. The second is that mass production in any industry must be destroyed or replaced as well as built up by scientific research. A high value must be placed on the services of the new class of worker engaged in research associations and industrial research laboratories, for they are the men who can utilize to the full, because of their understanding of purposes and methods, the advantages of personal contact with both the factory worker and the directorate.

Only by a true understanding of "science" can craftsmanship grow into all that it should be and stand for, Sir William concluded; and craftsmen learn to be of greatest use to their fellowmen.

The Live-stock Industry.

For the first time since 1912 the development of the live-stock industry was discussed by the Agriculture Section. Statistics show that in almost every part of the Empire, except Canada, the live-stock industry, including its products such as butter, cheese, eggs, etc., accounts for by far the largest percentage of agricultural produce. The imperial importance of the industry is apparent when we consider the dependence of the home population on foreign meat supplies. In the future, however, severe competition may be expected from the Dominions.

From the statistics given it is shown that although during the last fifty-five years the area cultivated for cereals in the British Isles has fallen by about 4,000,000 acres, the number of live-stock has increased and the density of the stock population has been maintained against severe overseas competition. These statistics are compared to those from Denmark where, in the same period, there has been an almost complete change from arable to stock farming. This change has resulted in a vastly increased area of arable land, since arable farming supports more stock than grass farming.

Since there has been a steadily growing demand for small joints within recent years, the problems confronting the industry are those effecting the early maturity and quality of stock. Unless the breeding stock of Britain is improved and graded up to a high standard, the general stock will never mature quickly nor improve in quality. Early maturity has the economic advantages of quick turnover, economical conversion of food, and higher command of price. State aid for the purpose of live-stock improvement is a development as recent as 1885. During the last decade, however, Canada and Northern Ireland have introduced legislation, resulting in grants for the purchase and licensing of high standard bulls for breeding, with very beneficial results.

The disparity between the commercial cattle and those of our pedigree herds in these islands is very marked—considering that the latter have been utilized to improve the world's stock. The urgency of the problem drew the following two proposals from Dr. Gordon: the desirability of (1) the increased use of pedigree sires, and in this direction the State can with great advantage to itself provide a powerful stimulus by the rapid extension of the premium scheme; (2) the elimination of the scrub bull, which, in his opinion, with human nature as it is, will only be accomplished in an effective manner by legislative means.

These proposals were among others advanced that showed how alive modern agriculturalists are to the value of breeding research, which may mean so much to the future of the live-stock industry.

Continental Drift.

In the Geology Section, evidence which strengthens the argument in favour of the German investigator Wegener's much-disputed theory of the drifting of the continents—upon a basic substratum of the earth's crust, the sima—was brought forward by Mr. E. B. Bailey in a paper on the palaeozoic mountain systems of Europe and America. The published paper, with the diagrammatic maps of the two palaeozoic mountain systems, is an admirable summary of the history of some of the problems which geologists had to face in elucidating the very complex tectonic structure of those regions where some of the oldest mountains on the surface of the earth once stood.

The evidence is mainly gathered from those areas where the two mountain systems—the Caledonian and the Hercynian—are found to cross one another. The main conclusion is that the tectonic structure seen to begin in South Wales is completed in New England—the trend of the two chains cross one

another. The study made of mountain chains, with their folds and their thrusts which individually may be of the order of one hundred miles, involves a recognition of some type of continental drift. Of late years Wegener has developed this idea on a particularly grand scale. He has accounted for many recognized correspondences in the geology of the two sides of the Atlantic by supposing that the ocean has flowed in between the Old World and the New, as the two continental masses, with geological slowness, drifted asunder. One cannot help feeling that Wegener may perhaps be telling us the truth. The available evidence is crude and ambiguous; but it is certainly startling to be confronted on the coasts of Britain and America with what read like complementary renderings of a single theme: the crossing of Caledonian Mountains by those of the Hercynian system.

Evolution Problems.

The Presidential Address to the Zoology Section upon "The origin and evolution of larval forms," can hardly be said to have a popular appeal, yet the conclusions drawn are important for a true appreciation of the problems of evolution. Professor Walter Garstang cited both the theory of recapitulation and the theory of adaptation, and enlarged upon a standpoint distinct from, yet related to, both of these. He illustrated the following propositions in regard to trochosphere larvae with several examples:—(1) the larva has a double task to perform, *viz.*, to distribute the species and to grow up into the adult; (2) of these tasks the first is essential, and the second subsidiary—to be undertaken only so far as the larval resources permit; (3) the performance of the two tasks together requires the maintenance of an equilibrium between the locomotive efficiency of the larva and the adult weight to be carried; (4) the locomotive adaptation of the larva may proceed on new lines, paying no respect to phylogeny, and culminating in some kind of change of form; (5) the modification of the larva in this way need not affect the organization of the adult, since the casting of the most hypertrophied of ciliated girdles involves only slight processes of subsequent repair.

The early evolution of the "torsion" of one order of the gasteropods is put down to the effect of larval adaptation. The torsion is of prime importance to the larva in enabling the head and velum to be safely retracted at the first onset of danger. No intermediate "links" of the evolutionary process of torsion have been discovered—hence it is inferred that an adaptation of very obvious use to the larva was almost immediately adapted to the use of the adult. The development of the marginal slit of the gasteropod shell gives further evidence in support of the theory that adaptations in the first instance arise early in the individual life-history. "On purely morphological grounds I attempted to show that we are under no intellectual necessity of concluding that everything new must arise late in the life-history," Professor Garstang concluded.

Preservation of Scenery.

An interesting conference session, where delegates from many archaeological and natural history societies gathered together in consultation with the British Association, took place during the week. Dr. Vaughan Cornish delivered the opening address on the preservation of scenic beauty in town and country. The urgent need for a comprehensive regional planning of the Lake District was emphasized at a second session of the conference. Uncontrolled development must be rigorously opposed by planning on a systematic survey of the region, which must result in meeting the demands for increased accessibility and at the same time those for the preservation of its solitudes and its wild life.

The Great Barrier Reef.

The report of the committee on the expedition to the Great Barrier Reef was submitted to the Association. The expedition left England early this year, on 26th May, and Brisbane on 11th July. Dr. C. M. Yonge, Balfour Student of the University of Cambridge, is director of the expedition, and will undertake all research on the feeding and limestone formation of corals and molluscs, and economically on the growth and feeding of molluscs, especially the pearl shell. The expedition includes fourteen other members, two of whom are attached as geographers, and five of whom are Australians who joined the expedition at Brisbane. The work to be undertaken includes the study of the geology of the land and coast-line, of marine biology, and of the growth, feeding and reproduction of the organisms in the vicinity of Low Islands, near Cairns, where the expedition is encamped.

All collections, with the exception of that of bottom living plants, will be worked out systematically and morphologically by the members of the expedition, in association with the director and committee. The first set is to be deposited in the Natural History Museum, and the second offered to the Great Barrier Reef Committee.

The cost of the expedition has been estimated at £10,500, of which over £2,000 is still required.

Book Reviews.

The Creator Spirit. By CHARLES E. RAVEN, D.D., Canon of Liverpool Cathedral. (Martin Hopkinson. 8*s.* 6*d.*)

(Reviewed by Mr. Alfred Noyes, C.B.E., LL.D.)

Dr. Charles E. Raven, in his volume entitled "The Creator Spirit," a survey of Christian doctrine in the light of biology, psychology, and mysticism, has made a real contribution to one of the great needs of the hour. A vast amount is being written at the present day on the foundations of religion in the light of modern thought, but the books that are of practical use to the seeker for truth, and are likely to bring any real illumination, are a very small and select band. Among them we must now place this volume, the sections of which were delivered as the Hulsean lectures at Cambridge and the Noble lectures at Harvard University.

Thirty or forty years ago the most striking characteristic of the conflict between religion and science (and in those days it was really a conflict), was the superiority in intellectual gun-power of the men of science to almost all of their theological opponents. With Darwin in command of the Grand Fleet of science, and Huxley taking the battle-cruisers into action, the antiquated ships of Orthodoxy, headed by the Ark, were sunk and battered into harbours from which they never emerged again into the open sea. But to-day there is a striking change in the situation, and the mere materialist who ventures to tackle any representative champion of idealistic philosophy, or indeed any competent theologian, in his own waters, is likely to be driven into an equally ignominious retreat. The "departmentalists" who have been engaged, on Victorian lines, in explaining away the higher values of life, have been hopelessly out-gunned. Nothing is more striking than the immense intellectual superiority, in range of thought, in grasp of philosophic principles, in clarity of logic, and in precision of statement shown by men like Dr. Gore, Dean Inge, Dr. Streeter, and now Dr. Charles Raven (all of them theologians), if their writings are compared with those of the merely materialistic men of science, who are perhaps more vocal than representative of their own great calling, at the present time. Interpreters of science like Sir Oliver Lodge and Professor Pupin are meeting the great idealistic philosophers more than half way in their refusal to be blinded (by the mere multiplicity of superficial detail) to the essential mystery that transcends reason, and cannot ever be *comprehended* by the reason, though man, being part of the same mystery, can *apprehend* it. Mere agnosticism is out of date.

But the materialist of to-day is as contented as the ostrich with the ignominious elevation of his tail in these matters. He delights to suppose that only the man who plants the cabbages of science is capable of thought. The hod-carrier of scientific "facts" is not only to supplant the architect, he is also to dictate the innermost beliefs of the man who is to inhabit the house; and, if this unfortunate being has any views of his own, based upon reasoning at least as valid as that of the hod-carrier, he is to be described as an arm-chair thinker, out of touch with reality. It is an interesting survey, from a new standpoint, that Dr. Raven has undertaken. He contends that, through the neglect of their own doctrine of the Holy Spirit, Christians have too often bound themselves more narrowly than was necessary within an ecclesiastical system, and that, in consequence, they have failed to interpret Creation as revealing the same values as their doctrines of Redemption and Inspiration.

He seems to over-estimate the extent to which science has shaken the belief of the best minds in the natural order as a revelation of God. To-day, as yesterday, the wisest saying that was ever appropriated by Lord Bacon remains true. A little knowledge leads men to atheism, but deeper knowledge leads them to religion. Unfortunately, the popular press seizes on every fatuous remark of the hod-carriers, and misleads the unscientific public as to the real state of affairs. London has recently been placarded with the statement "Science can create Life." In the scientific sense, of course, science cannot "create" anything. It can arrange, perhaps, and control the necessary material circumstances for the manifestation of life on earth, and that is all. The finest chapter in Dr. Raven's book is that in which he shows how the creative process (a process which Kelvin declared to be postulated, in the last analysis, by all true science, in all its departments), reveals its values. It appeals first to our sense of wonder; then to our sense of curiosity, by its order and design; and finally to our moral sense; the values thus disclosed being in harmony with the conclusion that the Spirit of God is the "Giver of Life," and leading on to the apprehension of the eternal reality behind phenomena. The passage in which Dr. Raven deals with the awakening of wonder, and the aesthetic values discernible in the natural order, is of remarkable quality.

"For me, and I think for many others, the immediate effect (of the impact of Nature) is sheer wonder—an awe which has in it both tears and laughter, both humility and exaltation. It is the poet that is fundamental in most of us—we are artists before we are scientists and philosophers—and the poet starts from the unity of the whole, not from the analysis of its parts. And as a poem the universe traverses the whole scale of our appreciation and satisfies every fibre of our being. . . . Here is art which breaks us with its terror, crushes us with its majesty, ravishes us with its joy, thrills us with its pathos, convulses us with its mirth; art in which thunder and mountains and harvest-field, snowdrop and centipede and puffin, octopus and antelope and little child have all their place; art perfect alike in its infinite variety and its balanced congruity. . . . And I see only a glimpse, I can measure but a fraction. Beyond my apprehension, too small, too great, lies marvel upon marvel. To watch the formation of crystals in the corpuscles in a drop of blood; to study the structure of a coral polyp, or the emergence of a moth from its cocoon; to feel the texture of a bird's feathers or listen to the thrushes at dawn; to trace the end of the rainbow or gaze at the rings of Saturn—that is the limit of my experience. . . . One needs eternity to tell the tale of it."

Dr. Raven's book is not the work of a departmentalist. In its combination of scientific knowledge with philosophic and religious insight, it should serve a great purpose at the present day.

The Romance of the Apothecaries' Garden at Chelsea. By F. DAWTREY DREWETT, M.D. (Cambridge University Press. 7*s.* 6*d.*).

In 1673 the Apothecaries' Company rented a plot of some four acres among the riverside pastures and market gardens of Chelsea to serve as an experimental garden for growing new medicinal plants and standardizing old ones. Their garden still remains to-day, an island of the rural London of the seventeenth century, unknown to most Londoners but not unvisited, for it has not achieved the melancholy distinction of a relic and show-piece of antiquity, but survives literally, living on robustly

in its old function of a scientific garden—a "Physic Garden" as its founders called it—and students are still working in its laboratories to-day, investigating the alkaloids of Henbane and the problems of grafting within sound of the motor buses of the King's Road, Chelsea. Its long active life has found a devoted and admirable historian in Dr. Drewett, whose book is a richly coloured picture of the great men—Sir Hans Sloan, Linnaeus, Sir Joseph Banks, and others—who were associated with the garden, of the everyday life of old (and modern) London, as well as of the garden itself with its old mulberry and persimmon trees and its beds laid out like "the pages of a living book on botany."

Dr. Drewett's book is not a mere chronicle of the dead past, but is as much alive as this garden, which, having given America its cotton and England its Cherrypie and Mignonette, is to-day distributing the seeds sent home by collectors in China and South America. The present edition is enriched by several new chapters and much curious learning, but is still all too short and it is to be hoped that its success may tempt Dr. Drewett to enlarge his field and to give us, perhaps, a book on the botany of everyday life or at least the "Treatise on String," of which he hints at the possibility when telling us about the Tamarisk bushes in the Chelsea garden and the rope of Tamarisk bark that was recently found at the bottom of a Roman well

F. A H.

Mr. Blettsworthy on Rampole Island. By H. G. WELLS. With a cover design by SIR WILLIAM ORPEN, R.A. (Benn. 7*s.* 6*d.*).

Many admirers of Mr. H. G. Wells in picking up his new novel will have retained from "The World of William Clissold" and "Meanwhile" a certain prejudice which not even an arresting cover design by Sir William Orpen can completely dispel. But when in the first few pages the reader is introduced to the "good broad Churchman," an uncle with whom Blettsworthy's boyhood is spent, the most biassed cannot fail to recognize the author of "Tono Bungay" and "The Time Machine" in his most pleasing vein.

It is true that the philosophy of the Rev. Rupert Blettsworthy is thrown into almost cynical contrast by its failure to influence the nephew when he found himself faced with reality; but that was mostly the fault of the nephew or his ancestry. Mr. Blettsworthy was born of a Portuguese mother, which may account for much of the weakness in his strangely lovable character. "At bottom we are all the same thing," the Rev. Rupert used to say. "Never get excited about forms or formulae. There is only one truth in the world, and all good men have got it." Darwin and Huxley he considered "sound Christians both, in the proper sense of the word. Honest men that is. No belief is healthy unless it takes air and exercise, and turns itself round and about and stands upon its head for a bit."

With such a background and an Oxford education, Mr. Blettsworthy experiences all too suddenly an unfortunate love affair and an equally disastrous experiment in business, which lead to a voyage round the world for his health. Next this "gentleman of culture and refinement"—so Mr. Wells describes him—is introduced to Rampole Island, as the result of a shipwreck; and here the doings of its cannibal inhabitants form a story reminiscent in the manner of its telling of Samuel Butler's "Erewhon." The records of anthropology surely contain no tribes more fascinating or more terrible than those here discovered, not least for the prehistoric Megatheria which still survive on the Island, age-old yet never dying. Blettsworthy had an intimate experience of the Megatherium in exploring its upland territories, where he was "roused from reflection by a flat loud bleating and a crashing of the undergrowth," and in fleeing away "could feel the hot reek of the pursuer's breath on his bare back."

By an accident almost as simple Blettsworthy escapes from the monster as afterwards from Rampole Island, returning to civilization in time to experience horrors in the War quite as devastating as any met with among the savages. Many recent writers have pictured war in all its nakedness, but none has shown the degradation and misery of it with greater effect than Mr. Blettsworthy, *alias* Mr. Wells. Even the opportunity which an eventful story provides for Mr. Wells's special talent does not allow him to escape completely from sociology, but the rather aggressive manner of some of his recent characters is more mellowed in Blettsworthy, and views are now seldom thrust at the reader.

To the least scientific mind the escape from Rampole Island proves exciting in its novelty, and to the psychologist Mr. Blettsworthy should provide an enthralling study. Much of the story is of scientific interest, and there are amusing details of this character, for example, the ship s engineer who "liked a *big* book about actual things."

"I had a book once," he related to Blettsworthy, "that told about the force in the tides and the waves. It's something terrific. There were calculations in that book. They went a little beyond me, but they were something striking. You could build a big tower and run all the trains in Europe and light almost everywhere with the force that wastes itself in one big blow like that. All gone to waste. Wonderful, eh?"

"Don't you believe it," said the mate. "You can't go against mathematics," said the engineer. "We live on the surface of things," Blettsworthy commented at this juncture

Though among the ship's company "nobody could find a handle on that remark," it will not be lost on the wider audience whom Mr. Wells always helps to get beneath the surface. And this time his friends will rejoice that he does so by telling a story —of the kind the Americans call "straight story."

J. A. B.

The British Sea-Anemones. By T. A. STEPHENSON, D.Sc. Vol. I. "Monographs of the Ray Society." No. 113. (London: Dulau & Co. Ltd.).

This delightful volume by Dr. Stephenson is a most welcome addition to British zoological literature. It is adapted not only to the needs of the specialist, but also to those of the ordinary lover of nature who spends some weeks of each year at the seaside. On every rocky portion of our coast there is no animal that more constantly obtrudes itself on our notice than the sea-anemone. Even in the most exposed localities where hardly any other form of life can endure the pounding of the billows the sea-anemone can be found clinging closely to the rock. Further, no marine animal survives better in aquaria than the sea-anemone, and so it is no wonder that this group of animals have always been favourites with amateur naturalists.

In the preparation of the volume under review, especially in making the paintings for the beautiful coloured plates which illustrate it, Dr. Stephenson has been largely aided by the work of his sister and his wife. From these plates the amateur may learn what the sea-anemones really look like when alive, which is very different from the caricatures of themselves presented

by their contracted and distorted bodies preserved in the jars of a museum.

The author begins with a long and clear account of the anatomy of anemones, explaining carefully all the technical terms used in their description. In doing this he confers a benefit not only on the amateur but also on the ordinary zoologist. Zoology has grown into such a wide subject with such complexity in details, that the zoologist in dealing with the special anatomy and classification of a group, unless it be his own favourite one has little advantage over the amateur. Zoology is indeed by far the most difficult of all sciences; the technique, it is true, of physics and chemistry, is more difficult than that of zoology, but once the preliminary technique has been mastered, results are obtained with comparative ease and certainty. But zoology dealing with that mysterious and evasive thing termed life requires often from its followers a lifetime in order to answer conclusively a simple question.

The ground plan of the anatomy of sea-anemones is comparatively simple, and is taught to all elementary students of zoology. But Dr. Stephenson shows us with what infinite variation in detail this plan is worked out, and the same is true of their habits. Whilst the ordinary seaside naturalist supposed an anemone to be fixed for life to a definite position on a rock, Dr.Stephenson teaches us that all of them can and do move, that some burrow in sand and mud, and some even float upside down in water. Again, whilst the majority of them use their tentacles to seize prey, some get hold of their victims by currents produced by bands of cilia on the disc, and some by turning the gullet half inside out after the manner of a starfish. This gullet, by the way, has always been believed to be an intucking of the outer skin or ectoderm. Dr. Stephenson suggests that this time-honoured statement may be mistaken, and that the gullet may owe its existence to a concrescence of the upper portions of the inner ends of those folds of the stomach-wall termed mesenteries. In this we think that Dr. Stephenson shows himself to be too much of a radical. May we direct his attention to Dr. Duerden's description of the development of a coral polyp, in which he figures a stage in which the stomach is represented by a mass of yolky cells not yet hollowed out, whilst the gullet is already an open tube in continuity with the outer skin or ectoderm and lined by a similar epithelium?

The volume which we are considering deals only with British anemones—and only, indeed, with half of these. We shall look forward to the publication of the second volume with interest and anticipated enjoyment.

E. W. MacBride.

Problems in Psychopathology. By T. W. Mitchell, M.D. (Kegan Paul. 9*s*.).

The author insists that study of the body has always been bound up with the study of the soul, and in his first chapter he gives a survey of the state of the science of psychology before the epoch-making advent of Freud, with particular reference to the knowledge of the forces at work in the production of hypnotic suggestibility and hysteria. Freud's new method of investigating the human mind followed up Breuer's discovery that symptoms of hysteria are related to forgotten events in the past life of the patient, and that the symptoms disappear if the events can be restored to memory. Dr. Mitchell discusses Freud's psycho-analytic theory of the neuroses, and devotes separate chapters to the explanation of what is meant by the terms *libido* and *ego*, showing that it is fear of the libido, expressed by the ego, which gives rise to the phenomenon of repression and the formation of neurotic symptoms.

Since it has been in the endeavour to formulate a consistent theory of the neuroses that medical psychology has made its most important contributions to general psychology, the author discusses the various theories, from Hippocrates to the present day, beginning with Plato's idea that the organ of generation becomes rebellious and seeks to gain absolute sway. Though Plato's theory of an "angry womb wandering through the body" is, of course, impossible of literal acceptance, he recognized the connexion between hysteria and the sexual life which Freud was the first in recent times to proclaim openly, the teachers of medicine before his time having apparently lacked the courage to communicate their knowledge even to their own pupils. The word "hysteria" comes, in fact, from a Greek word meaning "womb."

This volume appears to be based on a series of lectures delivered before the British Institute of Philosophical Studies, to an audience consisting, from the point of view of the psychologist, of laymen. They should, in book form, provide a wider public with a useful introduction to medical psychology and psycho-analytic theory, the value of which is enhanced by a summary of the concepts of post-Freudian medical psychology, such as those of Jung and Adler, which vary from the tenets of the master.

W. R.

The Social World of Ants. By Dr. Auguste Forel. Translated by C. K. Ogden. Two volumes. (Putnam. 63*s*.).

To the entomologist the name of Auguste Forel is well known as one of the leading authorities upon ants and as the author of "The Senses of Insects," but entomology is only his hobby. He is a well-known mental specialist in Switzerland, and is also a sociologist, having written a book upon "La question sexuelle." In the preface to this two-volume book of nearly one thousand pages, he mentions that he is seventy-eight years of age, and speaks of this as his last work. It is the result of more than seventy years study, as he tells us that he made his first observation upon slave-making ants at the age of seven and a half.

The book is charmingly written for the general reader, is couched in the most simple terms and, whenever a difficult scientific word is used, an explanation in brackets follows. The subject of ants is exhausted, chapters or sections dealing with structure, classification, geographical and geological distribution, physiology and habits, the industries of ants, and their relations with plants and animals. All this comes in volume 1, while volume 2 deals with the relations between different kinds of ants, followed by an "epilogue" which is almost the only part of the book in which the author lets himself go upon debatable subjects. At the end is an appendix by Professor Bugnion upon "The War between the Ants and the Termites: a Study of the Origin of Instinct," which has also been published separately and of which a review appeared in *Discovery* for September.

As a whole the work is a masterpiece, and criticisms are of a minor character. The earlier chapters are, in places, out of date, the terminology dating back to a time before entomology became a science. Dr. Forel describes the ant larva as being composed of "about twelve segments," and speaks of the "epinotum" as the fourth part of the thorax, saying that it is "more or less peculiar to ants." He refers to "adelphogamy" as unique in ants, although it certainly occurs in chalcids and

probably elsewhere. He describes the maxilla as the jaw, which he distinguishes from the mandible, and calls the ligula the "tongue." He states that the spermatozoa, on copulation, are "forced" into the spermatheca. On page 15 he states that "polymorphism in ants takes place in the egg," whereas on page 25 he says "we do not know where and when the differences between the polymorphic individuals begin" and, referring to a particular case, "here it is evident that differentiation must begin at a very early stage in the larva, if not actually in the egg." As a fact evidence seems to indicate that the caste is determined after the emergence from the egg, and it is even possible that sex may be reversed at this stage. Dr. Forel says that "terrestrial animals which are not able to endure the tropical climate cannot cross the equator unless they are borne by a swift steamship" (page 9), having apparently forgotten the possibilities of the mountain ranges. He suggests that the worker ants feed by endosmosis the developing embryos in the egg (page 21), although he mentions no evidence in favour of this view.

So far as the printing of the book is concerned, there are one or two mistakes. On page 23, an asterisk below figure 1 refers to a footnote, which says, "For the explanation of all these figures see the end of the Volume." As a fact, the explanation of figures is at the beginning of each volume. The references to figures or plates in the text often refer to the other volume, which is very inconvenient, if perhaps unavoidable. But the two volumes are beautifully got up, and both the translator and the publishers are to be congratulated upon it, not only as an ornament for the library but because it is a really good book.

FRANK BALFOUR BROWNE.

Music. By URSULA CREIGHTON. Illustrated (Chatto & Windus. 7*s.* 6*d.*).

For the second time within the space of a few short months a volume on musical history has appeared with the laconic title "Music." Sir W. H. Hadow's compression of nearly twenty centuries of musical history into six chapters had this single-worded description attached; the reason why its successor, Mrs. Creighton's book, is similarly entitled, is explained by it forming one of "The Simple Guide Series" of modern knowledge in science and art, and the title consequently, is merely indicative of the subject handled. Its scope may be inferred from some of the chapter headings, such as, "Early Music," "Polyphonic Music in England and on the Continent," "The Beginnings of Opera," "Bach and Handel," "Italian Opera," "Wagner," and "Some Modern Composers."

Obviously, in a short volume of some 250 pages, it is inevitable that a good deal should be left unsaid. But compensation for this concession to space demands is found in the demonstration that things, apart from persons, can be full of interest. It tells us less of prima donnas and pyrotechnics and more of the evolution of melodic forms and changes of harmonic fashion; although when dealing with the personal aspect three and a half pages devoted to Paganini (who contributed nothing to the advancement of the creative art) and only eight lines to Elgar is sufficient to cause more than a raising of the eyebrows. There is nothing of the hastily thrown together or slovenly written about this book, however; its subjects are discussed lucidly and closely. It is a pity "rhythm, melody and harmony" should have been printed and examined in that order, when the proper sequence in which to consider these elements is melody, harmony and rhythm. Music consists of tones heard in succession as in melody or simultaneously as in harmony; rhythm is that property of the one or the other, or both, which is dependent on time, but it does not take precedence. It is well, therefore, that before the author concludes her examination she concedes that "Melody is to us the essence of music."

H. H. W.

The Book of Remarkable Machinery. By ELLISON HAWKS. (George G. Harrap & Co. Ltd. 7*s.* 6*d.*).

From the wealth of material available for a book on this subject, the editor of the *Meccano Magazine* has ably compiled a short history of mechanical inventions from the time of the advent of steam power. There is a long story to be told from the time of the experiments of Newcomen and Savery to that of the work that perfects the modern calculating machine; yet the author has set out in an interesting and non-technical style the evolution of the machinery in use in several trades—including the iron and steel and the printing industries. The steam engine, the internal combustion engine, and the machinery on board ship are all described from their first simple beginnings in a way that attracts the attention of the non-mechanical mind.

The World in the Past. By B. WEBSTER SMITH. (F. Warne & Co. Ltd. 10*s.* 6*d.*).

The numerous well-chosen illustrations, many of them coloured, give this volume in the "Wayside and Woodland Series" an additional popular interest. The story of the geological ages is preceded by an introductory account of the importance and manner of operation of the chief agents of denudation which have acted upon the earth's surface throughout the ages until the present time.

As the title implies, the account given of the past covers a world-wide area. Thus the lay reader, for whom this book in the first place is intended, will not fall into the general error of expecting the geological classifications and history of north-western Europe to be world-wide in their application.

Perhaps undue importance has been given to the recent Ice Age which in geological reckoning was relatively an insignificant portion of Earth history. The popular interest in this more recent epoch may, however, fully justify the detail of this section of the book.

A. R. E.

David Livingstone, Explorer and Prophet. By CHARLES J. FINGER. (George Allen & Unwin Ltd. 7*s.* 6*d.*).

The author has no new material to add to the wonderful story of David Livingstone—his magnetic personality or his great discoveries, epoch-making in the history of the interior of Africa—but he brings out their value in a fresh and illuminating way. He himself, intensely interested in one or two of the more widely-known adventures of the famous explorer, went back to the original journal, *Missionary Travels*, and read for himself the explorer's own account which is so little known. He rewrites the story in a characteristic style which is easy to read.

The book should go far to disprove the impression of Livingstone in the mind of many as "a rather uninteresting fellow doing nothing more than preaching and going about with a Bible under his arm," and to demonstrate the true magnitude and worth of his discoveries.

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Editorial Notes.

Following our comments last month on the unsatisfactory position of public information about television, we have been afforded a special demonstration of the Baird Television Company's apparatus. It must be admitted at once that the improvement achieved since we last saw their results is perhaps more remarkable even than the progress from the outset in April, 1925, when *Discovery* first brought Mr. Baird's invention to public notice. The mere shadows which preceded the blurred facial image of a year ago have now given way to a fairly distinct picture, and the gold-rimmed spectacles of the sitter were clearly seen on the receiver as the head moved from side to side. Furthermore, in place of the battery of high-powered lamps to which the sitter was exposed before, a single beam of light now suffices for illumination. The method, however, still depends on mechanical revolving discs, and on the receiving screen a "flickering" image is unavoidable. We gathered that this disturbance had been reduced to the minimum on the present apparatus, and if it is inseparable from the transmission of so small an object as the human head, the day when larger scenes can be transmitted is evidently still a long way off. The American workers are using a similar apparatus, and it is significant that the "play" so widely announced as televised successfully now appears to have consisted merely of a series of head-and-shoulder monologues. This factor seems likely to be one cause for Mr. Baird's failure to satisfy the B.B.C. and the Post Office engineers that his system is as yet suitable to justify trial through a B.B.C. broadcasting station.

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On present lines television requires a wave length several times shorter than those being employed for broadcasting speech and music. The laboratory pictures are transmitted over a wire, which affords much clearer results than when the waves are broadcast through space and have to compete with atmospheric interference. For reasons such as these, which are dealt with on another page by Mr. Campbell Swinton, F.R.S., a critical attitude is necessary from the scientific standpoint. At the same time we cannot entirely agree with our contributor's somewhat pessimistic comparison with other forms of pictorial reproduction. The two ideas are by no means comparable. The chief object of television must be to convey a transient impression through the medium of the eye. Other forms of reproduction are by their nature permanent records. We hold no brief for any television system, but if it should be the case that the Government monopoly in broadcasting is holding up experiments—however crude—which might otherwise be proceeding apace, the position requires further explanation. As the result of the B.B.C. decision, the Baird Company have announced their intention to conduct transmissions in France and Holland.

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In these days the discovery of documents that prove of first-class importance to the historian is becoming of rare occurrence, if only for the reason that there is an increasing curiosity in the past. Few persons possessing books or papers of likely interest now fail to investigate them, yet that there is still unrevealed material is shown by the discovery which Sir George Aston describes in this issue. How he came upon the diary of an Austrian diplomat among the shelves of a country bookseller, is curiously reminiscent of the find by Professor Waterhouse of an unknown version of Goethe's "Faust," described in these columns a year ago. The career of Philipp von Neumann, the subject of the new discovery, has an interesting analogy in more recent times in that of

Walter Hines Page. Except perhaps that the late American ambassador had difficult relations with his own Government, who regarded him as pro-English, both these foreign visitors were popular in London society and both recorded their impressions. One aspect of the diary not mentioned elsewhere is that in writing it Mr. Beresford Chancellor has removed a few sentences likely to cause pain to living descendants of the persons concerned. There has lately been a crop of books published with apparently no other object than to damage great figures of the past, and Mr. Chancellor's example cannot be too widely praised or copied.

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Our recent paragraph on Dr. Robert Millikan's new theory of the universe has been expanded in the Messel memorial lecture, which he gave in New York to the Society of Chemical Industry. The theory rests on an exact measurement made of the amount of lead in a mineral known as Black Hills Uraninite, which, while no great technical feat in itself, has revealed the important knowledge that there is another term of a billion years for life on earth. From a correlation of Einstein's and Aston's recent work he comes to the conclusion that "radio-active disintegration with the ejection of an α-particle is a process that can take place only in the case of a very few of the very heavy and very rare elements." As the great majority of the elements constituting our world are in their state of maximum stability, there can be no utilization of energy consequent upon "exploding" the atom! On the other hand, atom-building is a source of energy. Dr. Millikan, in collaboration with Dr. Cameron, has isolated three definite cosmic ray bands with 12, 50 and 100 times the penetrating power that can be obtained from any disintegrating process. The most penetrating X-rays pass through three inches of lead but these new rays will traverse 200 ft. Sunlight has no influence whatever on their strength and they come in with equal intensity from all directions.

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Dr. Millikan reaches the conclusion that "the processes which give rise to these rays are favoured by, and actually have their source in, the places in the universe where the temperatures and pressures are extreme . . . that is, where they are close to absolute zero." There is thus pictured a continuous atom-destroying process taking place under the extreme conditions existing in the interior of stars, and from its influence an atom-creative process continually taking place under the equally extreme conditions of just the opposite sort in inter-stellar space. If these interpretations are true, then the universe is in a steady state. There is no "heat death" to be feared for the future of the universe, as the assumptions of Professor Jeans, Stern and others would require.

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One point emphasized by the National Radio Exhibition held a few weeks ago at Olympia was that listeners have much to be thankful for from the refusal in 1922 of the then Postmaster-General, the Rt. Hon. F. G. Kellaway, to grant a monopoly in receiving sets. "Every firm in the country capable of producing cheap and efficient receiving sets must be allowed to become a member of the Broadcasting Company on reasonable terms," was the principle on which the foundation of the trade was laid. In consequence of this far-seeing policy there were now nearly two hundred exhibitors showing a wide range of high standard material. Rivalry between the exhibiting firms has increased owing to the more critical attitude of the listener in regard to the performance of his set. On the other hand, a notable new development is the production of many more sets for the ever-growing public who enjoy solely the aural entertainment, and to whom wireless as a hobby makes no appeal. "Tuning-in" is often a long and tiresome process on the average two- and three-valve set, but one of the new models exhibited will receive six stations by no further adjustment than moving a single switch. Simplification, in fact, is perhaps the most notable tendency in wireless to-day.

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When the British Association visits South Africa for its meeting next summer, a question likely to be widely discussed is the origin, history and purpose of the prehistoric ruins at Zimbabwe and similar sites, chiefly in Southern Rhodesia. These monuments have been described and partially explored already, for example on the Association's previous visit in 1905 careful studies were made by Dr. Randall MacIver, whose conclusions, however, were not universally accepted, especially in South Africa. The further visit would therefore seem an opportunity to clear up these doubtful and other points. It has been ascertained that the Government of Southern Rhodesia would welcome such work, and the council of the Association has appointed to conduct it Miss G. Caton Thompson, who has had varied experience as an excavator in Egypt and Malta. We understand that there is already another expedition in South Africa engaged in prehistoric studies, and full justice should therefore now be done to an obscure and fascinating problem.

Television : Past and Future.

By A. A. Campbell Swinton, F.R.S.

After describing the history of television experiments, Mr. Campbell Swinton examines the principles on which present methods are based, and advances a possible solution of the problem. This article is commented upon in the Editorial Notes.

THE history of what is now known as television goes back for many years, and begins, so far as is known, with a suggestion of G. R. Carey, an American, as long ago as the year 1875. This suggestion was based on what takes place in the human eye, which consists of a camera obscura containing a lens whereby the image of what is looked at is thrown on the retina. The surface of the retina is composed of a mosaic of very minute cells each connected by a separate nerve fibre to the brain, so that stimulation of the different parts of the mosaic of the retina by the varying light of the image thrown on it by the lens, is carried by the nerve fibres to the brain, and there causes a conception of the image.

Early Ideas.

Carey's idea was to replace the mosaic of the retina by a mosaic of a large number of minute selenium cells, the electric resistance of which varies under the influence of light, and, further, to replace the nerve fibres by separately insulated electric wires carrying an electric current from a battery, and to use this device to vary the light given by a number of very minute electric lamps, equal in number to that of the selenium cells and of the electric wires, and so placed that each lamp would correspond in position to each of the selenium cells, and, by giving more or less light, would reproduce the image thrown on the selenium cells by a photographic lens at the distant end.

Similar suggestions for television were made by Ayrton and Perry, the English professors, in 1877, and also by E. Rühmer, a German, and Senlecq, a Frenchman, some of whom actually made working models based on this principle. At a later date, in 1908, Mr. Shelford Bidwell, in England, further experimented on the subject, and calculated that to give good close-grain results on a screen only two inches square would require no less than 150,000 each of cells, wires and lamps ; while to give very coarse results, about equal to the coarsest process blocks at that time used for reproductions in the newspapers, about one-tenth of this number would suffice, but that, in any case, the expense for transmission over any considerable distance would be quite prohibitive from a commercial point of view.

Since these far-off days there have been many and diverse suggestions for obviating the necessity for the enormous number of connecting wires required for any realization of Carey's proposals. These are too numerous and too complicated to describe here, except to the extent of mentioning that they comprised methods in which the use of both electrical and acoustical resonance was suggested in order to reduce the number of wires, the arrangements in some cases being similar to those used in multiplex telegraphy, where a number of different messages are sent simultaneously over the same wire.

Then came the idea that, instead of trying to transmit simultaneously the enormous number of separate signals required to deal with the various parts of the transmitted picture, these signals should be sent one after the other with sufficient rapidity that the sending of a complete set would occupy only one-tenth of a second, so that the persistence of human vision, which has about that duration of time, would simulate a constant effect and cause continuous perception of the results. This is, of course, the same idea as that embodied in the cinematograph, where succeeding pictures are usually projected so as to follow one another at the rate of sixteen per second, so that the eye does not notice the sudden changes in what it sees, but takes the motion of the moving parts as continuous. The difference between this application of visual persistence to television from its application to cinematography, is, that whereas in the latter they are complete pictures that follow one another in rapid succession, in the former they are only parts or elements of a single picture that do this.

All modern systems of television are based on this principle of dissecting the pictures to be transmitted, into a large number of elements which are signalled one after the other, the persistence of vision being relied upon to combine the pieces into a comprehensive whole. Moreover, there are only a very few main methods in use whereby this is effected, and all of them, though hailed by the press as examples of modern inventive genius, are really quite old. The

most favoured method for chopping up the picture into the required elements appears to be the use of revolving discs containing apertures staggered in position with reference to the centre on which the disc revolves, so that the beams of light passing through the apertures cover the whole picture, piece by piece, as the discs revolve. This idea is, however, as old as 1884, when a German, called Nipkow, patented it. Another method is to use mirrors fixed on the periphery of a rotating wheel, but this was proposed by Lazare Weiller in 1889; while rapidly vibrating mirrors for the same purpose go back to Szcepanik's patent of 1897. Even the method of illuminating the object to be televised by a rapidly moving spot of intense light, recently hailed as a new and important improvement, is not original, as it is described in the patent of the Swede, Ekström, of 1910.

If, however, anyone wishes to read a very complete technical account of the history of television from its earliest inception up to the present day, he is referred to the remarkably erudite and impartial article on the subject, called "La Télévision Electrique," written by Monsieur A. Dauvillier, the well-known physicist of Paris, and published by him in the *Revue Générale de l'Electricité* for 7th January, 1928. As will be seen from this historical account, there is very little new in modern methods of television at present in use. Most of the novelty consists in the application of thermionic amplifiers and other wireless appliances to assist the results.

Some Comparisons.

To judge from the enthusiastic paragraphs contained in some of the newspapers, it is doubtful whether the public realizes how very poor and limited are the results of present-day television as compared with other methods of reproducing pictures, such as are used in ordinary photographic prints, in cinematograph films, and in the better class of photographic reproductions in the papers; nor is it realized that present mechanical methods of television seem to give no scope for much improvement in this respect.

If we take ordinary photographs, the fineness of the grain of all descriptions of prints, whether the image consists of silver or carbon, or other materials, is very great, and cannot be detected by the naked eye nor even with considerable optical magnification. Indeed, lantern slides and cinematograph films are required to stand magnification to thousands of times without showing any noticeable grain. Even when we come to photographic process blocks such as are used for book illustrations, the grain is still very fine; and though we get to a coarser form of block that appears in some of the newspapers, we are still dealing with a granular structure that is built up of grains or dots to the order of thousands to the square inch. Thus, in pictures of any considerable size, the number of dots of which the picture is composed is very large, as, for instance, in a recent one in *The Times* depicting the Eton and Harrow cricket match, measuring about 16 inches by 10 inches in size, the grains or dots amounted to over a quarter of a million, or about 1,500 to the square inch.

Mechanical Factors.

Now, when we turn to the best that can be obtained with modern television, we find a very different story. In the best television pictures so far obtained, the light bands employed do not exceed about fifty in number, and if we make the reasonable assumption that these are each divided up individually into fifty parts, the total number of elements we have wherewith to construct the whole picture only amounts to 2,500 in all. Now, with so small a number, obviously only the simplest of very small pictures can be constructed, and as even with so small a number of elements, seeing that each has to be registered sixteen times per second, we have a total of 40,000 to be dealt with per second, which is about as much as the present mechanical means can manage.

So far, indeed, only the simplest forms of pictures can be dealt with satisfactorily, and when we come to actual facts, we find that this is the case. For instance, it is reported from the United States that one of the three well-known television concerns there recently made a pretence—one can call it nothing else—of transmitting a play by television. To begin with, in order to simplify matters, a play containing only two characters was selected, but even this was not a sufficient restriction to suit present television possibilities, and what was actually transmitted and received on a screen only four inches square were images of only the heads and shoulders of the two performers in the play. This gives some idea of what the newspapers call wonderfully successful television.

Recently there was reported in a well-known London journal that the paper had been televised, and one naturally supposed that at least the leading article could be read on the receiver. As it turned out, however, all that had been transmitted and received was the contents bill, consisting of print with letters probably whole inches in dimensions, none of the letterpress of the paper being decipherable at all.

It is not surprising, therefore, that it is very rarely that reproductions of the pictures actually received by television are published in books on the subject,

or in the accounts in the newspapers. What will pass muster as a likeness in a series of flashes on the dark screen of a televisor will not bear cold-blooded critical examination as a still photograph, and thus in all the vast amount of illustrated literature published on the subject during the past two years, there only appears to be a single facsimile of a portrait transmitted by television. This is supposed to represent a man's face, but can only, with some degree of imagination, be recognized as such.

This is very different from other methods of transmitting still pictures by wireless or wire telegraphy, where photographs are automatically transmitted dot by dot by slowly rotating apparatus. Here, photographs can be reproduced virtually as good as the originals; but it is one thing to send still pictures at a rate at which it takes several minutes to complete the operation, and quite another when the whole operation has to be repeated completely sixteen times in every second, as is the case with television. In the former case, large and complicated pictures can be transmitted as easily as small ones, though at a greater expenditure of time, while in television the time limit of one-sixteenth of a second necessary to avoid flickering quickly puts a limit to the size of the picture and also to the number of elements into which its complication requires that it ought to be divided. This in many ways is unfortunate, as for exhibition purposes it would be well if the received pictures could be optically enlarged and thrown on a screen that a considerable audience could see. This, however, is at present out of the question, as if even the best results of television are much magnified, they become entirely unintelligible.

A Suggested Solution.

It is reasons like this that years ago prevented the development of television, as those interested foresaw the extremely limited nature of what could possibly be obtained by all forms of television which depended upon the mechanical movement of material parts, such as discs or mirrors; and even to-day there are those who doubt whether all the money, time, and trouble that have been spent in bringing mechanical television to its present stage of development has not largely been wasted, as it seems that it can only lead to a dead end beyond which no improvement is possible. Amongst those who hold this view is the present writer who, some twenty years ago, put forward a suggestion whereby television might be obtained without the use of any mechanical moving parts at all, the only moving things employed being the electrons of cathode rays, which are practically free from inertia, and, moving as they can be made to, at velocities approaching that of light, which is no less than 186,000 miles per second, are at the same time the most docile entities in all nature, being easily and practically instantaneously controlled in their movements by both magnetic and electric fields.

Only recently no less an authority than Sir Oliver Lodge, who, let it not be forgotten, is one of the original inventors of wireless telegraphy, has revived this idea by publishing several articles advocating that an experimental attack should be made upon television by means of electrons, whereby it is hoped that the present limitations of mechanical methods may be eliminated. Until some success has been obtained in this way, and television is rendered able to deal with much larger and more complicated figures than its limitations at present allow of, it is scarcely open to much doubt that the promised televising of extensive scenes, such as a cricket match at Lord's, or the race for the Derby, will remain impossible of achievement.

Murder by Telephone?

THE dramatic title above is not abstracted from a novel by Mr. Edgar Wallace but is given to an announcement issued at Princeton University, U.S.A., by Professor William Richards, of the Department of Chemistry. Experiments are being made with super-sound waves of high intensity, which, it is stated, will burn a man's finger, kill small animals, shatter glass, cause explosions, boil liquids, and accelerate certain chemical reactions. Human beings could be killed if they should come under the influence of waves of sufficiently high intensity, it is remarked. The super-sonic waves, which are waves of sound too intensified to be heard by the human ear, are produced by a quartz crystal oscillated by an apparatus similar to that used for radio broadcasting.

When the waves are turned upon a glass receptacle containing pure water, the water becomes turbid with minute particles of glass torn or "atomized" from the sides of the container. Gases are expelled violently from liquids by the waves and liquids are caused to boil at temperatures below their usual boiling point. Water, for example, will boil at 98° Centigrade, instead of at 100°. In frogs and mice the waves cause anemia which apparently leads to death. Although somewhat similar in action to waves set up by explosions, supersonic waves are differentiated by their characteristic of recurrence. As the waves alternately expand and contract, there is a corresponding fluctuation of high and low temperature in the matter which they strike.

The Finding of the Neumann Diaries.

By Sir George Aston.

By the author's discovery of a diary kept throughout the reigns of George IV, William IV, and the earlier years of Queen Victoria, much new material has been revealed to the historian. Identification was complicated by imperfect handwriting and the fact that the manuscript was in French.

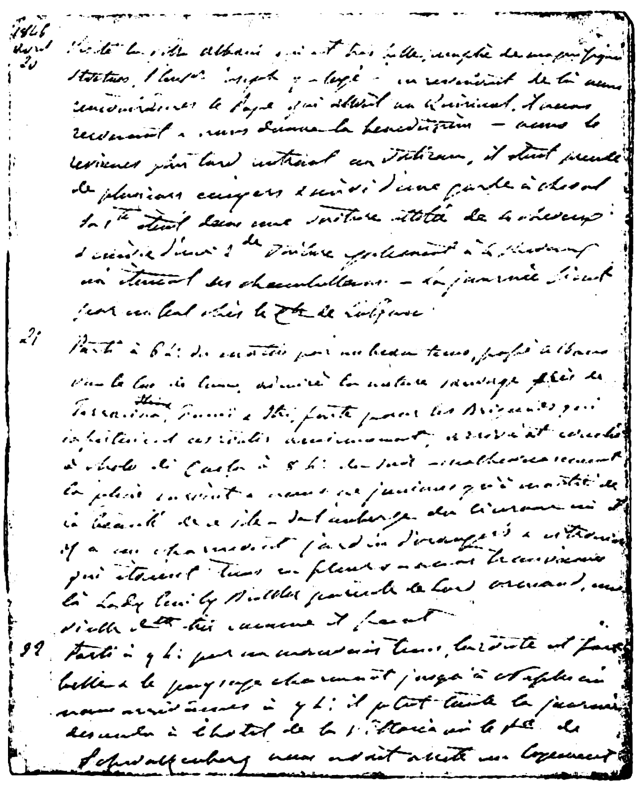
I REALLY cannot claim to have found the diary of Philipp von Neumann, the Austrian diplomatist who throws so much light upon social life in England and upon European history in the reigns of George III and IV, William IV, and the early years of Queen Victoria's reign. It would be more accurate to say that the diary first found me. I live in a country village about five miles from Salisbury. When in the city with time to spare, I spend it talking to Mr. H. M. Bates, the bookseller, with whom I share an affection for old oak, old books, and fly-fishing.

When we were so engaged about two years ago, he asked me whether I would care to buy a bundle of copy-books, written in French in the form of a diary, which he had obtained with other odds and ends from a colleague in Frome. He believed them to contain the diary of Lady Georgiana Codrington, whom he thought was the wife of the Admiral of Navarino fame, as the diary contained references to that battle. The authorship was so described in his printed catalogue. I could see no reason why the good lady should have kept her diary in French, so I took no further steps at the time. Later on I thought matters over, and I finally decided to buy the manuscript and to spend what time I could spare in further investigations.

As a member of the committee of the Institute of Historical Research in Malet Street, Bloomsbury, I had access to the wonderful library there, so it was an easy matter to discover that the name of the wife of the victor of Navarino was Jane, not Georgiana. I then referred to Lieutenant-General Sir Alfred Codrington, with whom I had contracted an acquaintance when we returned in the same transport from the South African War. I asked him whether he had any letters from his late relative Lady Georgiana. He soon found some, and we compared the handwriting. He found it so similar to that in the diaries that I thought that Mr. Bates must, after all, have been right. In order to make certain, we checked the dates of her letters, and the places from which they had been written. This showed us at once that we were on the wrong scent. The entries did not agree. Then, early in July, 1926, I had the good fortune to meet at a history conference Professor Paul Vaucher, of the University of London. He was good enough to undertake to look through the diaries, which are very voluminous, and to give me his opinion on their authorship, if disclosed. His report, dated 16th July, 1926, lies before me:—

"The diary appears to be the work of an Austrian diplomat M. de Neumann, who was at the Austrian Embassy in London from 1815 to 1821, again from May, 1822 to 1825, and from 1828 to 1829. (See Record Office Indexes of Foreign Office Papers.)."

Professor Vaucher was good enough to add references to early extracts from the diaries containing evidence in support of his opinion. The first extract showed that "the author is a gentleman"—"is not an Englishman"—"is a diplomat sending despatches to Vienna." Then:—"The whole diary shows that he is



By courtesy of Messrs. Philip Allan.

A PAGE OF THE DIARY.

working under Prince Esterhazy, the Austrian Ambassador. His rank is not indicated, but he comes no doubt immediately after the Ambassador himself. He is a man of rank and considerable importance. (The Regent talks with him on German affairs, 4th December, 1819. During a visit to Paris on 3rd April, 1831, he dines with the Royal Family and is seated next to the Queen.) He has not the rank of *ministre plénipotentiaire,* but in 1827 he is sent to Brazil on an independent mission—Esterhazy asks for him the new post of minister at Brussels (22nd October, 1831) but he is not appointed; see 26th November, 1831. I therefore think that the author must be M. de Neumann."

Professor Vaucher, after quoting further corroborative evidence, wrote that the diary is interesting because the diarist gives the general news on current events, repeating anecdotes and news that he heard. He was in close relation with the Duke of Wellington, and when Talleyrand was appointed to the French Embassy, Neumann was in the habit of dining with him *en famille* two or three times a week.

Through Professor Vaucher's kindness I was thus put on the scent, but about eight years' experience in the research methods of real historians, under Professor A. F. Pollard at the Institute of Historical Research, had taught me to beware of such expressions as "I think." I next applied to the Austrian Legation in London, and they were good enough to apply to the archivists at Vienna, who offered to place all their resources at my disposal. They sent me a short biography of Neumann from the *Haus-Hof-und Staatsarchiv,* which contains very comprehensive material about him. The report began :—"He was born in Vienna about 1778, married in 1844 Lady Augusta Somerset, died at Brussels the 14th January, 1851." Due note will be taken of the point that there is no mention of parentage in the report. On this subject Mr. Buckland, of the Record Office, called my attention to a letter from Ernest of Hanover to Lord Strangford attributing the paternity to Prince Metternich, but this, from its source, seemed to me to be mere gossip unsupported by evidence.

I then sent the original diary to another friend, P. B. M. Allan, the publisher, who noted the point about marriage with Lady Augusta Somerset (sister of the Lady Georgiana Codrington, mentioned above) in 1844, consulted the manuscript, and found the reference to his marriage by the diarist. This finally established his identity, and the chase was over. Mr. Allan offered to publish extracts from the diaries, translated into English, enlisting the aid of Mr. Beresford Chancellor for the purpose as editor.

By courtesy of Messrs. Philip Allan.

ANTONIE VON LAYKAM.

Second wife of Prince Metternich, from a painting by Johann Ender.

A long delay ensued, on account of the difficulty in finding someone to type out the six hundred pages of French manuscript, closely written in handwriting not easy to decipher. One French lady, after long delay, threw up the task. In the end, I was so fortunate as to obtain the help of Miss Z. Faiers, of the staff of the Institute of Historical Research, who not only typed clearly two copies of the whole manuscript, but also deciphered the numerous names, both of eminent and of hitherto obscure folk, whom the diarist mentions.

That is the story of the discovery of the Neumann diaries, and of their authorship. It was a good hunt, and I commend such a chase (as being superior to "hunting for spectacles," sometimes called the last sport of the aged) to those in search of a hobby.

The diaries with which Sir George Aston deals above have now been published by Messrs. Philip Allan,* by whose kind permission the illustrations are

**The Diary of Philipp von Neumann.* 1819-1850. Translated and Edited from the original manuscript by E. Beresford Chancellor, M.A., F.S.A., F.R.Hist.Soc. (Two volumes. 42*s.* the set).

reproduced, together with the following notes from Mr. Beresford Chancellor's preface.

Writing of Neumann, Mr. Chancellor enumerates the unusual circumstances which combine to give his record of men and things a significance of its own—the high and responsible position which Neumann occupied; the large and varied circle of his acquaintances; his interest not only in his special world of politics and diplomacy, but in those of art, music, and literature; his undoubted charm of manner which made him a favourite at court and welcome amongst the highest circles of at least three capitals. The diary has, too, as agreeable a variety in its tone as it has in the topics with which it deals. It must also be remembered of Neumann that when we follow him to his own country, unlike some who have found favour among foreigners but have not been so universally successful among their own people—like the proverbial prophet he was, if possible, even more a *persona grata* there than in England.

The Manuscript.

Throughout the diary, even when it perpetuates serious and important matters, makes light and pleasant reading. For it is really a diary, written clearly with no thought of publication, and thus free from that somewhat factitious style which, in spite of their essential value, detracts from the easy charm of not a few similar records. The Neumann diary is of additional interest in that it is the only one covering a similar period besides the well-known one kept by Charles Greville. But Greville's diary, invaluable as it is, is here and there verbose; and—especially in the later part—if the truth must be told, a trifle heavy. Indeed, it is not a diary or journal so much as an elaborate record of selected events and a collection of character-studies. Neumann's record is, on the other hand, a diary pure and simple. The original manuscript consists of about thirty-five sections, written closely in French on both sides of the pages and extending to some 400,000 words. To have published the whole would obviously have been excessive, and by editing, the grain has been relieved of most of the chaff. Mr. Chancellor assures the reader, however, that no serious omission has been perpetrated.

The entries are frequently made more valuable by notes of conversations, anecdotes, and gossip of the day, and then they become important as helping to build up a picture of English society at a time when that society was undergoing a change from the free-and-easy days of the Regency to the strict and immaculate *aura* spread over it by the influence of Queen Victoria and Prince Albert. For the period during which Neumann was living in this country, and noting daily some event of more or less importance (from 1819-1850, though not continuously), was one of the most interesting and significant in our annals. It was the end of one *régime* and the beginning of another.

A New Era.

Stated in simple words, the blusterous age of George IV, whose characteristics were to no little extent carried on during his successor's ten years of sovereignty, suddenly gave place to a sedate and temperate period; and a fact recorded by Neumann that cards were not permitted at Windsor on a Sunday can be placed as a companion piece to the lurid happenings at Carlton House and the factitious atmosphere generated from the Cottage in Windsor Park of but a decade earlier. It does not always follow, of course, that the example set by a Court is necessarily followed by Society at large, but in the case of Queen Victoria, Society began to be influenced by the young Queen; and if it never wholly resigned itself to the restrained manners and decent customs of a new *régime*, it took care to act outwardly as if it did. The moment between the death-bed scene at Windsor and the famous early morning scene at Kensington Palace inaugurated an entirely new scheme of things.

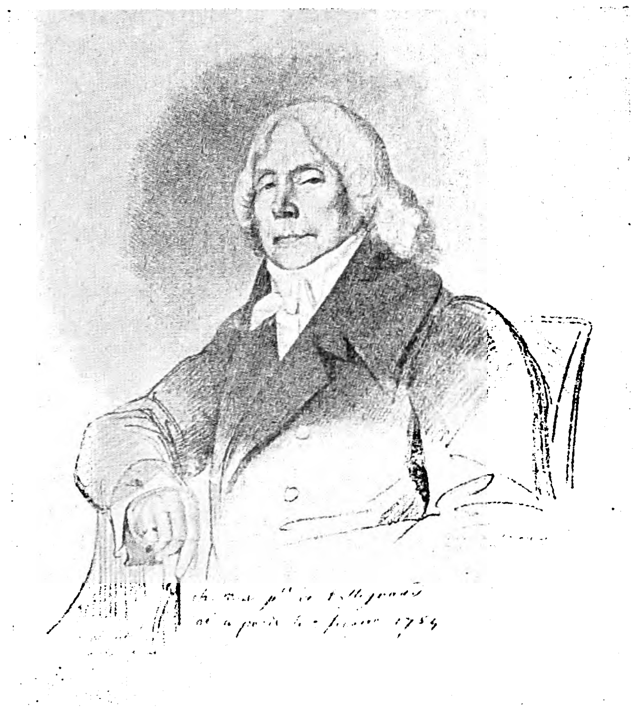
The outstanding events which are, *inter alia*, recorded in the diary, comprise the accession and coronation of George IV, the Cato Street Conspiracy, the trial and death of Queen Caroline, the death of Napoleon I, the murder of the Duc de Berry and the fatal accident to the Duc d'Orleans, the trial of Hobhouse before the House of Commons for libel, the death of George IV, and accession of William IV, the excitement incident on the introduction and passing of the first Reform Bill, the revolutions in Spain and Portugal, the death of King William and the accession of Queen Victoria, her marriage, the two attempts on her life by Francis and Oxford, the Chinese and Afghan Wars, with a long *et cetera*.

Neumann in the course of his diplomatic duties, as well as on the occasions of holidays and pleasure jaunts, travelled about much both in England and on the continent. In some cases his itinerary and the time occupied in travelling, which he is at pains to record, are of no little value as indicating the marked differences in the mode and time occupied on a journey a hundred years ago from what obtains to-day. For example, he records on 10th July, 1830, that the news of the capture of Algiers five days

previously proves the utility of the telegraph! On other pages of the diary a full account is given of a journey to Brazil, which enabled Neumann to investigate a country which was then something of a *terra incognita*; and his descriptions of the rulers of that land, its natural characteristics and potentialities, will now be read with especial interest.

His criticisms of people are as acute as those places. Sometimes he gives a character of a man or woman which, if not on the full-length scale affected by Greville, nevertheless conveys a vivid impression of the personality described. That Neumann was undoubtedly a "lady's man" is brought out by his many references to the brilliant figures of the day. For example, on hearing of the death of the young Princess Metternich he was "overwhelmed with grief," not only at the heart-rending sorrow of Prince Metternich himself, but at the loss of an intimate friend.

At other times he records the opinions on momentous occurrences which he hears from the lips of their protagonists—Talleyrand or Wellington or Metternich,



By courtesy of Messrs. Philip Allan.
PRINCE TALLEYRAND.
From a sketch made in London in 1834.

as the case may be. We thus obtain from the diary much information bearing on famous events from, as it were, a new angle; and if a few of the anecdotes are already known, by far the majority are new.

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Correspondence.

IS THERE A SURPLUS MALE BIRD POPULATION?

To the Editor of DISCOVERY.

SIR,

In the letter from Mr. M. P. Price I think I recognize the style, and ability as a field naturalist, of a former pupil of mine at Harrow in 1900. If so, his "Vertebrate Fauna of Harrow," published in 1903, recording his original observations here, still remains the standard book on the local avifauna and bears witness to his powers of observation even at that age. Mr. Price has rightly forgotten what I tried to teach him about some interesting existing work on the question he has raised, but as Mr. Nicholson does not mention it either in his reply, I venture to draw your readers' attention to it, instead of merely writing to Mr. Price.

I do not possess the "Proceedings of the Zoological Society," so can only quote from memory and from my lecture notes culled from various sources, but in this connexion more particularly from a paper by Stolzmann in the "P.Z.S." of 1885.

Stolzmann advances a theory of his own to account for sexual dimorphism in birds. When I was a boy I had the privilege of hearing Dr. Alfred Russel Wallace discuss this theory in his own study when he was challenging Darwin's theory of Sexual Selection—Wallace, of course, was developing his own views on both surplus vitality and the protective colouration of the nesting females as more efficient causes of the divergence of the sexes.

Although it is only the data which are germane to the point at issue, it may be worth while recalling Stolzmann's theory—its validity does not matter, but its ingenuity is considerable. Stolzmann satisfied himself as to the reality of the surplus male bird population. He argues that these surplus males are a serious disadvantage to the species—the unattached bachelors persecute the females during courtship and even incubation, causing potential divorce cases in the bird-world during this important period for the species—and also diminishing the available food supplies, etc., for the mated pairs of their own species.

Therefore anything tending to reduce this surplus number will be seized upon by Natural Selection and perpetuated. So the bright colours of the males have been evolved in order to attract attention and increase the death rate amongst them. They are rendered more visible to their enemies and more freely killed by hawks and other foes—their display plumes make them less efficient on the wing—and their very pugnacity leading to their killing each other also helps to reduce their number and thus benefit the species as a whole.

I have done but scant justice to his theory in this outline, for those who are interested a large array of facts are given in support of it by Stolzmann in his paper. But the dominant issue of the whole theory and the hypothesis on which it rests is the existence of this surplus male population. Stolzmann collected very large numbers of the same species of birds in Peru, and he gives his figures showing how far the males outnumbered the females in his series.

In my note is also the statement that of 980 birds collected by Mr. Guillemard on the cruise of the *Marchesa* round New Guinea 584 were males, 285 females, and 111 of undetermined sex—giving on any distribution of the last number a considerable numerical superiority of males. I cannot remember if this last

set of figures is given by Stolzmann or if it comes from another source.

Of course, it matters considerably under what conditions Mr. Guillemard got his birds, for the very fact that the males are conspicuous—not so shy—and not occupied with incubation would make them an easier prey to a collector and therefore likely to preponderate.

The whole question has stuck in my mind and made me keep my notes, because it was the first scientific inquiry with which I was ever concerned personally. Dr. Wallace suggested to me that I and my boy friends should shoot, catapult, or trap "a few hundred starlings and house-sparrows" for him. We boys took this commission with the most whole-hearted approval! In the course of the winter of 1886 we provided him a total of 812 sparrows and 289 starlings. Dr. Wallace pronounced his results as sparrows—433 males, 379 females; starlings—157 males, 132 females. I well remember him pushing his spectacles up over his bushy eyebrows and commenting on his figures:—"Well, you see Stolzmann was right about the cock-birds—I wonder why that is so." The murders were committed at Godalming in Surrey—I do not attempt to justify them though the diminution in the sparrow population may have helped the local gardens. But for other species, at all events, more humane methods such as Mr. Nicholson suggests, are certainly to be preferred.

Two further observations bear on this part of the subject. My friend, Mr. Vesey Stoney of Rosturk Castle, Westport, Ireland, is a keen ornithologist and trained observer. He has kept careful observations of the choughs which occur in large numbers in his district. There is a large non-nesting surplus over mated birds—these remain gregarious throughout the year, and he is satisfied that these flocks are males—though personally I should not care to distinguish males from females.

The other point is that my nesting boxes in the spring are frequently captured by house-sparrows instead of the lesser-spotted woodpeckers I hope for. Quite frequently two cock-sparrows seem to be associated with one hen-sparrow and one nest. I have not seen unmated hen-sparrows about, but I cannot vouch for the relationships in these trio nests. By the time I see them they seem to be settled down to this state of affairs—neither male resisting the other. Possibly it is a case of incipient polyandry, but it indicates more males than females. Stolzmann in his paper concludes that the male preponderance is chiefly due to the influence of nutrition upon sex: males resulting from badly nourished eggs and females from the better nourished—much as the queen bee is produced from a larva which has been specially fed. But the validity of this hypothesis raises another question—well treated in the "Origin of Sex," by Geddes and Thomson. Stolzmann maintains that owing to nest-building, incubation, etc., in many species, the female has less time for supporting herself than the male—and possibly the active males, if they are in better condition than the females, will reproduce more males. A naturalist taking up this inquiry presumably would be able to determine if there is any difference from others in sex ratio in those species in which the males incubate or assist in incubation.

I do not recollect if Stolzmann offers any explanation of brilliantly coloured males in polygamous birds—in any case, if there is any rule of surplus males they must be an exception.

Yours sincerely,

ARCHER VASSALL.

Elmfield,
Harrow-on-the-Hill.

PULVERIZED COAL FOR SHIPS.

To the Editor of DISCOVERY.

SIR,

We note on page 286 of the September number of *Discovery* a paragraph dealing with pulverized coal for ships, in which it is stated that the steamer to be built for the Berwindmoor Steamship Co. of Liverpool will be the first ship built or owned in Britain in which this method of using coal will be introduced. This statement is not correct, as we have equipped the first British-built steamer with pulverized coal equipment and this steamer, the T.S.S. *Stuartstar*, has completed a round voyage of 13,000 miles to South America and back with one of her main boilers burning powdered coal. This has proved so satisfactory that we are now fitting this steamer with further equipment on the Tyne, and she will sail on another voyage to South America next week.

The *Stuartstar* is the pioneer British vessel to use this method of burning coal, and we shall be glad if you will correct the statement referred to above. For a description of the *Stuartstar's* voyage we can refer you to the Technical Press, "The Journal of Commerce" of Thursday, 6th September, and *The Times, Morning Post*, etc.

Yours faithfully,

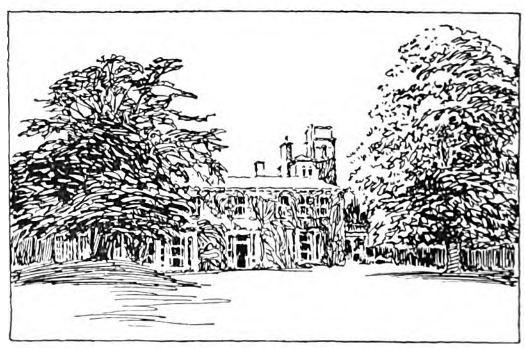
BLUE STAR LINE (1920) LTD.,
E. A. THOMSON,
Senior Superintendent.

40, St. Mary Axe, E.C.3.
15th September, 1928.

We understand that the vessel referred to in our paragraph will be the first specially designed and built for the use of pulverized coal. No doubt other vessels have been adapted for this fuel.—ED., *Discovery*.

A MEMORIAL TO COBDEN.

READERS of *Discovery* are invited to support an appeal which has been issued, with a distinguished non-party endorsement, for the permanent endowment of Dunford House, near Midhurst, Sussex—the home and birthplace of Richard Cobden. The intention is to use the residence in the interests of the promotion of political and economic peace between the nations through the medium of conferences, vacation schools, and similar



gatherings. It is the property of Cobden's surviving daughter and of her husband, Mr. Fisher Unwin, who as a memorial to Cobden's life and work are presenting to the world in permanent trust the house and grounds, together with his library, portraits, and other historical treasures. To secure the efficient working and permanence of the memorial it is necessary that an endowment fund of £25,000 shall be raised. American co-operation has been definitely promised, conditionally upon adequate support for the project from Great Britain.

The Problem of Russia.

By R. B. Mowat, M.A.

Professor of History in the University of Bristol.

Surveying the present relation of Russia to the rest of the world and to Europe in particular, Mr. Mowat suggests historical grounds for predicting that a solution of the problem may not be so far distant as is commonly supposed. Will Russia become a strong bulwark of peace?

IT is often said, and with a great deal of truth, that the Bolshevik Revolution has cut Russia off from the rest of Europe. Russia, however, in spite of the spread of Western civilization in the eighteenth and nineteenth centuries, has never been as fully "in" Europe as, for instance, France or Holland. The difficulty of the Russian language, the defectiveness of means of transport, tended to cut Russia off from the stream of European travel. The illiberalism of the Tsarist administration system also deterred visitors from Western Europe. Thus Russia has always been something of a closed book.

A recent work* points out that the Ural Mountains, which so plainly marked off Europe from Siberia on the maps of our early schooldays, have no such geographical or social significance. They are "a geological rather than a geographical landmark." Russia is a huge, and on the whole, flat country, stretching from the Danube to the borders of China, from the Carpathians and Baltic to the Pacific. Russian geographers have given it the name of Eurasia. It is half in Europe, and half in Asia. Mediterranean civilization, which is the civilization of Western Europe, did not take Russia within its sphere. In the years between 988 and 1010, Christianity came into the country, but it was the Christianity of Constantinople, of the Greeks of the Byzantine Empire.

The Orthodox Faith.

"In receiving the Orthodox faith from the Greeks, Russia received a purer and more genuine form of Christianity than it was granted to the West to receive; but the separation of the Churches . . . elevated a barrier between Russia and the Latin West which was for many centuries complete." It also prevented Russia from sharing in the spiritual and intellectual stimulus, and in the religious purification, brought about after the close of the Middle Ages by the Reformation and counter-Reformation.

In the early Middle Ages a large Slavic kingdom came into existence around Kiev, on the river Dnieper. In the eleventh century Kiev is said to have rivalled Constantinople in culture and in mercantile importance; but after the year 1070 the kingdom declined, owing to the invasions of a Turkish tribe called Cumans or Kipchaks. The Cumans were followed by the Mongols or Tatars, who, under Genghis Khan, swept over the country in 1224. Sixteen years later another terrible drive of the Mongols under the grandson of Genghis Khan resulted in the destruction of the city of Kiev. Many Tatar chiefs settled down on the steppe-land in southern Russia; but in the forest-land to the north of Novgorod became a wealthy merchantile, free city, paying tribute to the Tatars.

Independance.

Novgorod, however, never made itself the political centre of Russia. This position was to be taken by Moscow, a city subject to the Tatars or "Golden Horde" as they were called. After 1380, when Dmitri, Prince of Moscow, defeated the Tatars at Kulikovo, the Tatar power gradually declined. Ivan declared his absolute independence from the Tatars in 1480. In 1547 Ivan IV assumed the title of Caesar or Tsar.

The Moscow princes had thus freed Russia from Oriental conquest. It was, however, probably a misfortune for Russia that the Empire of Kiev had not survived, so that this city could be the capital. Moscow is not merely further east than Kiev (*see* map, page 347), but it is on no great river, no natural route of communication.

Thus the tendency of Russia to remain secluded from Western Europe was confirmed and even increased. Moreover, the legacy of Oriental invasion and devastation remained; what is called the backwardness of south-eastern Europe, says a writer in the "Cambridge Mediaeval History," on "The Asiatic Background," is due to this—to centuries of frightful onslaught and immigration from the most savage races of Central Asia. "They came every summer, carrying away thousands of Russian captives, whom they sold as slaves in the Mediterranean markets. As late as 1571 they burned the very suburbs of Moscow."

*"A History of Russia," by Prince D. S. Mirsky.

In the sixteenth century, contemporaneously with the reign of Queen Elizabeth in England, Russian political power began to extend over Siberia, and in the course of some forty or fifty years reached the Chinese frontier. Thus " Eurasia " became politically and geographically one. About the same time the Tsarist autocracy became complete. There was a Parliament in Russia in the sixteenth and seventeenth centuries, a Parliament of clergy, nobles and townspeople. This body elected the first Tsar of the Romanov line, Michael, in 1613; and in 1649 it completed the process by which the feudal nobles had been steadily enslaving the peasantry. The reactionary condition of Russian society is seen in this fact, that, while in the seventeenth century serfdom in Western Europe was practically ceasing to exist or was being greatly diminished, in Russia the bonds of peasant servitude were being drawn closer. The Parliament of this year (1649) which imposed the civil code including serfdom was also the last Parliament of Russia for two hundred and fifty years. The Deputies did not like attending Parliament, and acquiesced when the Tsar ceased to summon them. This happened under Tsar Alexis, a pious gentleman and dignified ruler, whom Prince Mirsky calls " the last, and perhaps the best, incarnation of the harmonious equipoise of the Muscovite mind."

Light from the West.

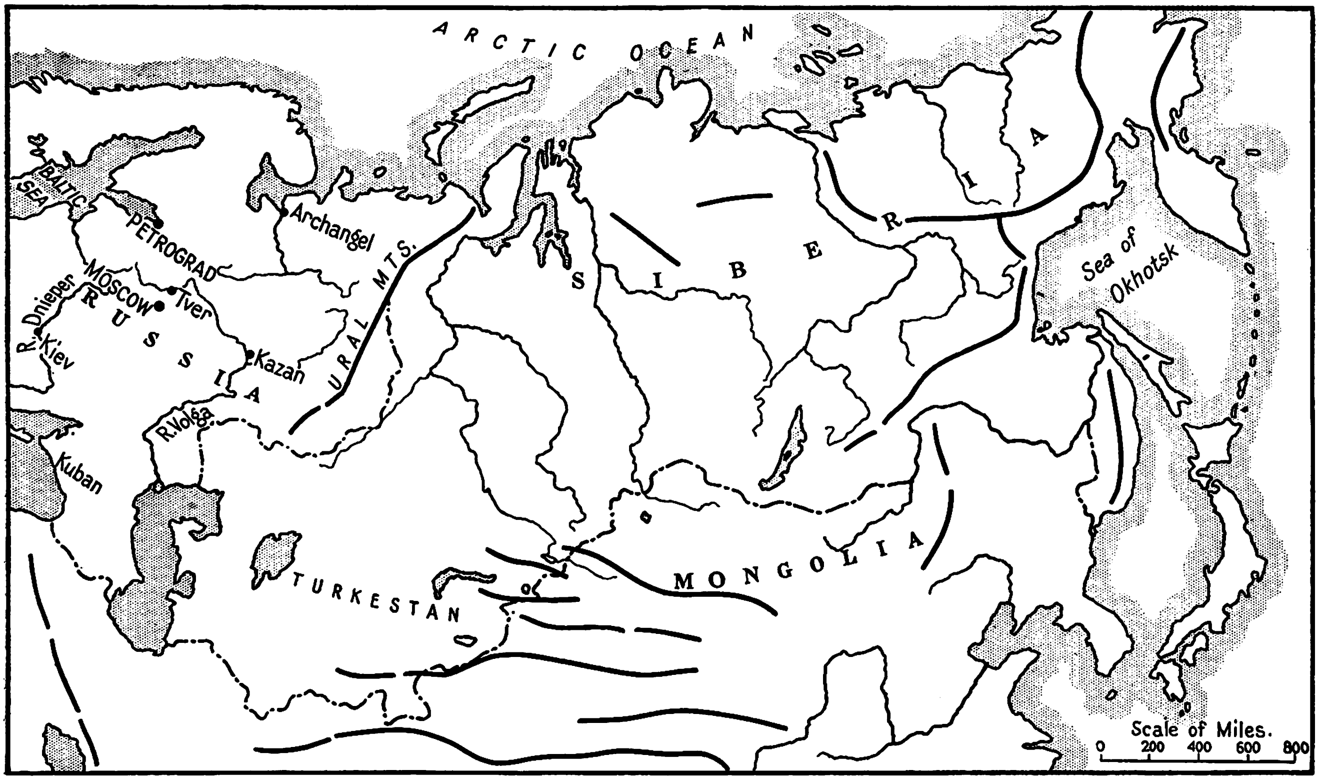
Light from the West, chiefly regarding technical and administrative affairs, came in about 1669, when the high official, Artamon Matveyev, gave employment to Germans. Matveyev's Germanophile policy had great influence upon Peter the Great, who employed many foreign administrators and mercenaries. Peter's long and ultimately successful war with Sweden (1700-1721) ended with the annexation of the Baltic provinces, and so brought Russia physically further west. But most of his administrative reforms perished with him in 1725; and his attack upon old Muscovite manners merely brought " moral anarchy " into Russian high society and engendered the licence, of which he himself was such a glaring example.

In the eighteenth century the stream of foreign culture coming into Russia was no longer German but French. Modern Russian literature may be said to have begun. The University of Moscow was founded in 1757. Education spread among the nobility and bourgeoisie. The reign of Catherine II (1762-1796), was "the golden age of the serf-owners." The enlightenment of this philisophic Empress did not inspire her to do anything for the peasants. The administration was made more uniform and systematic; the huge Russian bureaucracy began to take its modern shape. Immense territorial extensions were made at the expense of Turkey and Poland. Thus the Western trend of Russia was made more definite; but the Russian people were still really outside the essential influences of the West; the French Revolution touched them not at all.

The Holy Alliance.

The most European in policy of all the Tsars was Alexander I, the creator of the famous Holy Alliance of Monarchs. His minister Speransky, who admired Napoleon and the Napoleonic régime, introduced French models and methods into the Russian bureaucracy. For a time the ally of Napoleon, Alexander, after the failure of Napoleon's Moscow expedition, followed the defeated French into Germany, and finally in 1814 to Paris. In the great Congress of Vienna which made the peace settlement, Russia stood out as a Great European Power. The Holy Alliance of 1815 was based on the brotherhood of European Monarchs. Unfortunately it set itself against Liberalism, the most characteristic movement among the European peoples in the early nineteenth century. Thus Russia came under the suspicion, in the eyes of Western Europe, of being the champion of autocracy and reaction. When the Tsar Nicholas I sent his army to prevent the secession of Hungary from Hapsburg Austria, in 1849, this suspicion was confirmed. In engaging in the Crimean War, five years later, France, Great Britain and Sardinia, held that they were not merely fighting for the integrity of Turkey, but that they were opposing the apostle of anti-nationalism and reaction.

The defeat of Russia in the Crimean War and the death of Nicholas I brought a period of iron despotism to an end. Under the rule of the humane and liberal Alexander II the serfs were freed, the civil and criminal codes were modernized, railways were constructed, provincial elective assembles were established; Russia seemed at last on the road to becoming a normal European state, of the Western, liberal or " bourgeois," type. The most statesmanlike of the Tsars had just appointed a commission to make studies for a further move in the direction of constitutional reform, when he was killed by the bombs of revolutionary conspirators (1881). The succeeding monarch, Alexander III, and his advisors at once abandoned all idea of further reform. Alexander III, however, was peaceful, and was always on friendly relations with the other European monarchs. Russia grew in wealth and in intellectual culture, and might fairly have expected a liberal régime when the twentieth century opened.



RUSSIA IN EUROPE AND IN ASIA.

The reign of Nicholas II never fulfilled these hopes. First the extension of Russian influence into Manchuria provoked a disastrous war with Japan. The failure and the loss of prestige of the Imperial régime gave opportunity for the outbreak of a revolution in the year 1905. There were ten days of street fighting in Moscow. The Government triumphed after considerable bloodshed, but it seemed to have learned almost nothing. During the revolution the Tsar had promised to summon a Parliament or Duma with legislative authority. This promise was carried into effect, but the Duma was never allowed to become much more than a debating society.

In the years before the War, the Russian Government and, in general, Russian public opinion were strongly pan-Slavist. By this attitude, or policy, they contributed to the high tension of international feeling, the prominent feature of those dangerous years. When the war broke out the bureaucracy assumed the congenial task of taking into its control every department of the Russian national life. The bureaucracy struggled manfully but was not capable for the gigantic task. Defeat and exhaustion gave opportunity for the outbreak of Revolution in 1917; first the Liberal, next the Socialists, finally on October 25th, 1917, the Bolshevik Revolution.

The problem of Russia, namely, how its position in Eurasia can be adapted to normal relations in the family of European states, remains apparently as far from solution as ever. But perhaps this is not really so. It is true that the Bolshevik Government has declared war upon the existing European economic and social system, and proclaims that it would like to see this overthrown; and by this attitude it has largely shut itself off from Europe. On the other hand, by acquiescing in the secession and independence of the non-Russian Baltic peoples and of Poland, Russia has made more possible than it was before, a peaceful condition of international affairs in Central Europe.

At present the Bolshevik Government, antagonistic to, and antagonized by, the rest of Europe, has turned its attention more and more towards the East; has reverted to a semi-Asiatic or Oriental outlook; has recognized Russia as being the land Eurasia, outside Europe. It may be, however, that this dual location, this Eurasian continuity of territory may provide the means of bridging the political and social gap between Europe and Asia. Modern means of communication have made the size of the world to shrink; international relations are closer than ever before and are world-wide. Europe is no longer a self-contained continent in international relations. In these world-wide international relations a healthy Russian state, planted firmly in Eurasia, could be a strong link and a bulwark of peace.

Was Wordsworth ever a Mystic?

By George McLean Harper.

Professor of English in Princeton University, U.S.A.

Questioned in his old age about some lines from the "Intimations Ode," Wordsworth gave an explanation which implied that his youth was imbued with mysticism. Professor Harper, the well-known biographer of Wordsworth, questions this view by examining afresh the circumstances in which the lines were written.

WORDSWORTH is regarded by many as a high-priest of supernaturalism, a poet whose peculiar gift of imaginative insight gave him glimpses of a spiritual world of which the material world is only a garment. He is frequently quoted in support of idealistic systems of philosophy, some of which suggest or even proclaim that matter is a product of mind, others that it is merely a symbol or temporary representation of mind, and still others that it does not exist at all except in mind. These views undoubtedly give comfort to certain souls weary of what is impermanent and imperfect and longing for what cannot change or degenerate. It remains to be proved, however, that mind is more enduring or more perfect than matter. This problem is beyond the scope of ordinary mortals. But one may hope to throw some light on Wordsworth's relation to it.

Wide Misunderstanding.

There is no other great poet who is so much misunderstood. Most readers dip into his works here and there without noticing the dates of the poems. They attach equal weight to passages written forty or fifty years apart. They do not know the facts of his life, which was a stirring mental and moral drama, marked by tremendous changes of direction. To illustrate or reinforce some opinion, political, social, aesthetic, religious, or philosophical, they quote Wordsworth, not telling or perhaps even observing in what period the lines were composed. This is as if someone were to use an early utterance of Saul of Tarsus to prove that Paul the Apostle was not a Christian, or to cite Lincoln's Emancipation Proclamation of 1863 as evidence that he was an Abolitionist in 1855. In order to understand Wordsworth it is necessary to know the main facts of his life, especially his inner life. The chronology of his works is an absolutely indispensable thread for anyone who wishes to find his way through them understandingly. Wordsworth deliberately cut and tangled this thread by arranging his poems, in his later editions, according to an arbitrary classification, under various emotions and by species or kinds of verse-forms. It is a misleading arrangement, early and late poems being in many cases printed side by side.

But the young and greater Wordsworth, the hopeful revolutionist, the pacifist, who "flourished" between 1792 and 1802, the bold and original explorer in philosophy and religion who survived for six or seven years longer, was a very different man from the cautious conservative, the militant patriot, the defender of accepted views, who replaced him and lived on till 1850, disapproving of him in part and yet not altogether unlike him. The two lives overlapped. Between 1802 and 1815 there was an exhausting struggle between them, and there are few if any spectacles in the whole range of literary biography more thrilling than this contest between the early and the later Wordsworth. From my window I see the tall trunk of a once splendid ash-tree which was stripped of its limbs in a storm several winters ago. If the tree had then died it would have left a happy memory of strength and gracefulness. But the sap continued running, and now a second growth of branches, miscellaneous in form and not symmetrical, though umbrageous enough, has shot up from the vigorous stump. It is the same and yet a different tree. Thus it was with Wordsworth. The tempest of common sense, conformity, utility, and other excellent but prosaic elements beat upon him sore between 1802 and 1815 and stripped off his boldest opinions and purposes.

Let us take, from three widely separated periods, three records of his thought on the relation between mind and matter. In *The Times Literary Supplement* for 27th May, 1926, was printed an account of a conversation between Wordsworth and Bonamy Price, which occurred presumably in July, 1844. Quoting the mysterious lines from the *Intimations Ode,*

> Not for these I raise
> The song of thanks and praise;
> But for those obstinate questionings
> Of sense and outward things,
> Fallings from us, vanishings;
> Blank misgivings of a Creature
> Moving about in worlds not realized,
> High instincts before which our mortal nature
> Did tremble like a guilty Thing surprised,

Price asked Wordsworth what they meant, and gives the answer as follows: "The aged poet was walking in the middle; he at once raised his tall form erect, he passed in front of me and went up to a five-barred gate which lay in the wall that bounded the road. He then grasped it with his hands firmly, pushed against it with force, and then uttered these ever memorable words: 'There was a time when I was often forced to grasp, like this, something that resisted, to be sure that there was anything outside of me. This gate, this bar, this road, these trees fell away from me and vanished into thoughts. I was sure of the existence of mind; I had no sense of the existence of matter.'"

A World of Ideas.

The Rev. R. P. Graves, of Windermere, one of the adoring band of orthodox and conventional neighbours and visitors who tried to appropriate Wordsworth in his old age, hanging upon his lips and sometimes interpreting his utterances in their own sense, gave a similar account: "I remember Mr. Wordsworth saying that, at a particular stage of his mental progress, he used to be frequently so rapt into an unreal transcendental world of ideas that the external world seemed no longer to exist in relation to him, and he had to reconvince himself of its existence by clasping a tree or something that happened to be near him. I could not help connecting this fact with that obscure passage in his great *Ode on the Intimations of Immortality*." And then Mr. Graves quotes the lines cited above.

These anecdotes, even when every allowance is made for the orthodox desires and expectations of Price and Graves, may be accepted as showing that Wordsworth, when over seventy years of age, believed in the independent existence of mind or spirit, and that he thought he had entertained the same belief when he was young.

Forty years earlier, in 1804, writing the Third Book of The *Prelude*, he described a similar and yet significantly different state of feeling. Here he tells us that when he was a student at Cambridge he perceived a soul in material things:—

> To every natural form, rock, fruit, or flower,
> Even the loose stones that cover the highway,
> I gave a moral life: I saw them feel,
> Or linked them to some feeling: the great mass
> Lay bedded in a quickening soul, and all
> That I beheld respired with inward meaning.

The Ode, *Intimations of Immortality from Recollections of Early Childhood*, was begun in 1802 and finished in 1806. Its main subject is the vigour, splendour, and freshness of a child's perceptions and the authority which this vision of the world ought to have over the life of the growing youth and the mature man. A secondary subject is the inference that the soul of the child comes from a previous existence equipped with powers to appreciate what it discovers here. The first subject has to do with matters of experience not altogether uncommon; the second with what may be called mystical or metaphysical speculations. The poet admitted that too much weight should not be attached to these latter. The Ode is loved by many readers. I have loved it from boyhood myself. But I understand it less and less as years go by; that is to say, I find it increasingly difficult to explain as a whole. And I have never seen an explanation that was satisfactory. One loves it for the beauty, especially the musical beauty, of many lines and passages, and for a vague suggestiveness which it exhales like a mysteriously sweet odour. I am far from wishing it were other than it is; but just to show how different this kind of poetry is from certain other kinds, let us try to imagine how inadequate a prose paraphrase of it would be, or what a sorry mess it would make if translated into French verse. The poem laughs at logic. Fortunately Wordsworth did not write or dictate a long explanation; perhaps he could not explain it fully, even to himself. The looseness of its construction suits the filmy, tenuous character of the ideas which it not so much expresses as suggests and evokes. We are thus reminded of the too often forgotten truth that poetry is primarily music; and music rarely tells a story or teaches a lesson.

Everyday Things.

The years 1797 and 1798 were the great years of Wordsworth's mental and moral growth and also of his poetical originality, the years when he was most individual in his purposes and methods. It may seem contradictory to say that this was the time when he lived in the most intimate spiritual communion with Coleridge. Then it was, too, that the quick eyes of his sister Dorothy were most actively foraging the world of little things, the world of daily experience, for incidents and objects that might serve these young poets as material for composition. It was at this time that Wordsworth wrote the first draft of a poem which was intended to be a companion piece to Coleridge's *Rime of the Ancient Mariner*. Their plan was that Coleridge should treat a supposedly supernatural event with such attention to natural detail as to produce an effect of reality, while Wordsworth was to choose a subject from real or

common life and throw over it a glamour as of the supernatural. Wordsworth accordingly wrote the poem called *Peter Bell*, which was a very different thing originally from what it became before he finally published it, after cautious revision, more than twenty years later.

"Peter Bell."

In the Prologue to *Peter Bell* three stanzas still stand which express Wordsworth's purpose in writing the poem, as mentioned above. They are based upon his political doctrine of human equality and are furthermore an aesthetic and religious creed. He will be satisfied with the material which common everyday life supplies to a poet or seeing man. Nature alone, with no help from theology, no supernatural revelation, no interference from outside, is sufficient to make man good and great and happy. This may or may not be a sound creed (I think it is not), but it was Wordsworth's at the age of twenty-eight. The stanzas are as follows:—

Long have I loved what I behold,
The night that calms, the day that cheers;
The common growth of mother-earth
Suffices me—her tears, her mirth,
Her humblest mirth and tears.

The dragon's wing, the magic ring,
I shall not covet for my dower,
If I along that lowly way
With sympathetic heart may stray,
And with a soul of power.

These given, what more need I desire
To stir, to soothe, or elevate?
What nobler marvels than the mind
May in life's daily prospect find,
May find or there create?

I do not believe that in the period of his life when he wrote those lines he felt impelled to grasp trees or gates in order to make sure they existed. He was then a professed rationalist, interpreting life from the facts of experience and content, for the time being, not to look for anything else. This is the most satisfactory period of his career: he was consistent, original, brave, and gloriously productive. If he had had enough "natural piety," that is, reverence for his youthful ideals, to stick to this creed through the trying years of the Napoleonic wars, he would have seemed very impious, no doubt, to some of those who formed the circle at Rydal between 1815 and 1850, and his biographers would have had a less puzzling task, and English poetry would have been the poorer by some magnificent lines, and Church and State would have lacked his support; but the promise made in *Lyrical Ballads* might have been even more richly fulfilled than it has been. That promise is condensed in the stanzas just quoted from *Peter Bell.*

A poet, of all men, ought to know that matter exists. It is his calling to see in nature much that is hidden from other men and to present it in its beauty. If he wishes to go farther and declare that either in nature or behind nature there is a soul, the way is open to him; but he must first be aware of nature and in love with her. In a letter to Professor Henry Reed, of Philadelphia, written in 1845, Wordsworth declared that what he most valued in his poetical attempts was the spirituality with which he had endeavoured to invest the material universe, and the moral relations under which he had wished to exhibit its most ordinary appearances. This surely was a worthy purpose and was nobly carried out; but it is not what is generally called mysticism; at least it is not unusual or peculiar to poets or specially Wordsworthian. Paradoxical as it may seem to say so, Wordsworth was more of a mystic when he was most conscious of the reality of matter and most interested in its variety and beauty. This was in his early days; and of his faith at that time we have an amazing confession in the *Lines composed a few Miles above Tintern Abbey*, in 1798, where he is bold enough to say of himself "I am

well pleased to recognize
In nature and the language of the sense
The anchor of my purest thoughts, the nurse,
The guide, the guardian of my heart, and soul
Of all my moral being."

Nothing more unorthodox could be imagined. It is a frank abandonment of the belief, old as the memory of mankind, that God and nature are separate, that soul and body are distinct, that matter has no mind. This attitude alarmed the more theologically trained Coleridge, who expressed regret that his new friend Wordsworth was "a semi-atheist." If any other readers of the poem when it first appeared really understood the full significance of the words they must have been shocked. If they were personally acquainted with the poet they must have known him to be extremely exact and scrupulous in his use of language. It will not do, even at this late day and in view of his subsequent conversion, for us to say, "Ah well, he only meant that he perceived and worshipped God in nature." He was far too downright and honest to have said one thing and meant another so different from it. He really believed and declared that nature was itself divine.

Wireless as an Aid to Navigation.

By Lt.-Col. Chetwode Crawley, M.I.E.E.

Deputy Inspector of Wireless, G.P.O.

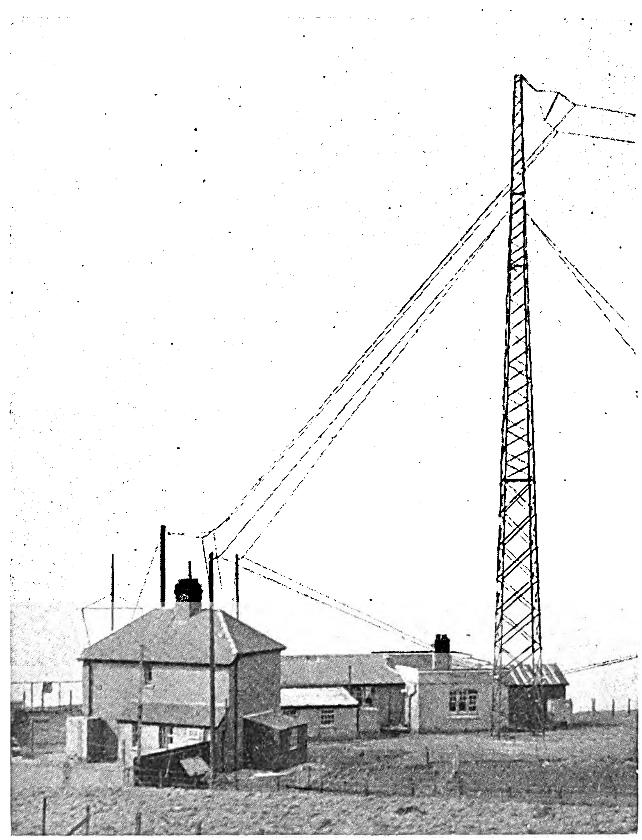
Great progress has been made in the technique of wireless communication during the last two years, principally due to the use of "short wave" transmission, but the advance in wireless as an aid to navigation, though quite as impressive, is much less widely appreciated.

THE results of Mr. Marconi's earliest experiments clearly foreshadowed the application of wireless signalling to the needs of navigation, but the wider field of commercial communication led to development along other lines. In his first practical signalling experiments Marconi transmitted the signals in the form of a beam of waves, similar to the light beam of a searchlight, and it is obvious that these waves could be utilized for navigational purposes, as a ship which received the signals would know that it was in the path of the beam, and therefore on a known bearing from the transmitting station. But the drawback of this method of transmission was that reflectors had to be used at the sending station, and these reflectors were only effective if waves of very short length were employed. Such waves, however, were only suitable, with the knowledge then available, for reception over very short distances, and the paramount importance of wireless signalling over long distances altered the whole course of development into another channel. Short waves and reflectors were completely discarded, and for twenty years wireless engineers concentrated on the development of communication by long waves over great distances.

But Marconi never quite lost sight of his early beams, and he returned to the old ideas for experiments in connexion with some problems which arose during the war. From these experiments has been developed the short wave beam system which has revolutionized the whole outlook of wireless communication during the last two years. These short wave beams, however, have not yet been adapted commercially to navigational purposes, though the Marconi Company have erected two experimentally to assist the navigation of ships, one in the Firth of Forth, and the other at the South Foreland in Kent.

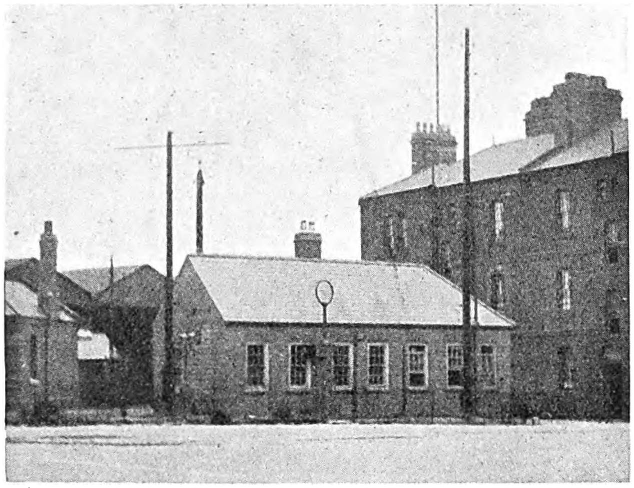
At these stations the transmitting aerial is mounted on a revolving carriage fitted with wire reflectors, so that a rotating beam of waves is transmitted. When the beam rotates distinctive signals are made as it passes through the different points of the compass. The ship merely listens to the signals and makes a note of the strongest signal heard. The bearing represented by this signal is the bearing of the station from the ship. The practical drawback to this system is that only very short waves can be used, and at these particular stations a wave of about six metres is employed. Such short waves are not at present practicable for the communication of ships over long distances, and a ship's ordinary receiving apparatus cannot receive them. This means that any ship which intends to make use of such stations must be specially fitted for the purpose, and as the system has not been generally adopted shipowners do not feel justified in going to the expense of installing this special apparatus. Ships can obtain a bearing from stations on this system up to a range of about fifty miles.

The idea of a rotating wireless transmitter is



DIRECTIONAL RECEIVING AERIAL.

The wireless coast station at Portpatrick, showing the directional receiving aerial of the fixed double loop type, two large loops, each of a single wire, being used. The screening arrangements used in ships are not here necessary, and there is plenty of room for a large loop which increases the sensitivity of reception.

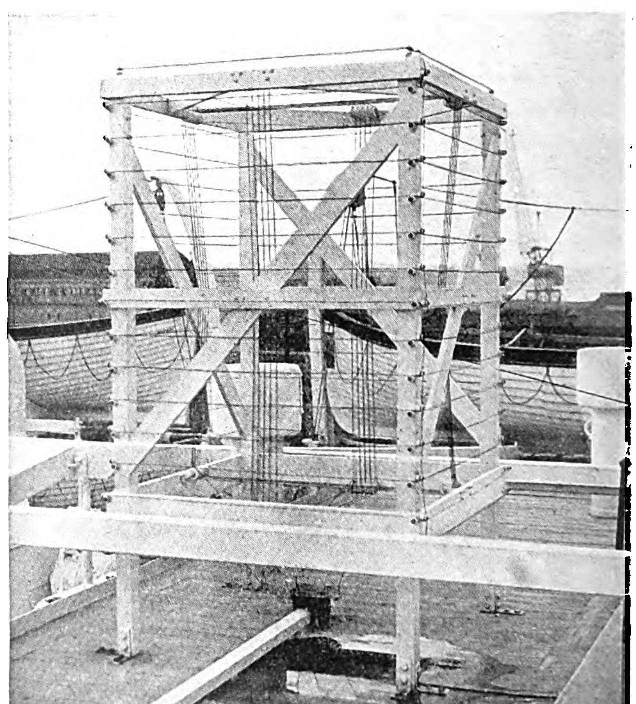


THE LIVERPOOL COAST STATION.
The station is in the centre building, where the small revolving loop of a directiona receiving aerial is seen.

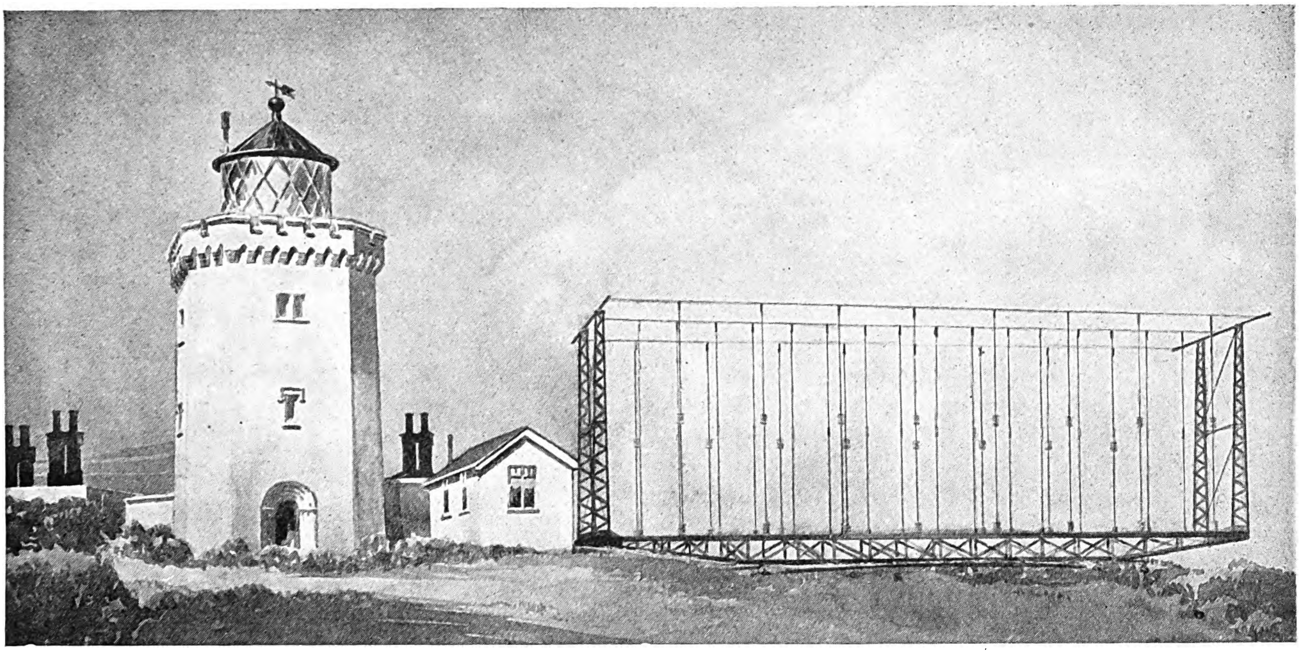
very attractive provided that the signals can be received on the ship's ordinary apparatus, and the Radio Research Board is developing a beacon on these lines. A station for trial with ships is now being erected by the Government at Orfordness. At this station the aerial will consist of a vertical closed loop which will be made to rotate at a uniform speed of one revolution a minute, the emission of wireless waves taking place in the plane of the loop. A signal of constant radiation is sent out throughout the whole period of operation except when the loop is in a North-South or East-West plane, when characteristic distinguishing signals are sent. The strength of the signal, as received by the ship, varies from a minimum when the plane of the station's aerial loop is at right angles to the ship's line of bearing from the station, up to a maximum when the aerial loop comes into line with this bearing. The ship receives the signal on its ordinary receiving apparatus, and the only special instrument required for calculating the bearing is a stop watch, which the operator starts when one of the characteristic signals is received and stops when the emission is heard weakest. In practice, of course, the operator goes through this operation a number of times and takes the mean of his observations as the correct bearing. Preliminary tests with this form of beacon, using ships' ordinary waves, have shown that the bearings are sufficiently accurate for ships' navigational purposes up to a range of about fifty miles, and for aircrafts' navigational purposes up to about two hundred miles.

The outstanding advantage of this type of beacon—and it is an advantage of the greatest importance—is that the ship requires no special receiving apparatus ; but it is much more costly than an all-round beacon, requires more attention in operation, and, owing to the space required, is not adapted for installing in lightships, which are often suitable places for wireless beacons from the navigational point of view.

An all-round wireless beacon is one which sends out wireless signals of the same strength simultaneously in all directions, and can be made use of only by those ships which are fitted with directional receiving apparatus. Of the British ships now equipped with wireless only fifteen per cent are fitted with this special apparatus, but this percentage will no doubt increase rapidly as the number of beacons on shore is increased, and as shipowners become more impressed with the potentialities of these directional receivers. Not only can such receivers be used for obtaining bearings from wireless beacon stations, but they can be used for obtaining bearings from any ships or stations which transmit signals on the wave-lengths used for ships' communications. Under normal conditions the bearings so obtained, up to one hundred miles or so, are sufficiently accurate for the purposes of navigation. When conditions are not normal, and bearings unreliable, the operator is aware of the fact in nine cases out of ten. There is, of course, the danger of this tenth case, but its possibility being known its real danger is to some extent discountenanced, as



AERIAL FITTED IN A SHIP.
This directional receiving aerial is of the fixed double loop type, each loop consisting of five wires. The whole system is enclosed in a wire screen, which reduces the possibility of inaccuracies arising through the movement of derricks or similar metal bodies in the vicinity. It is analogous to the metal screen round a compass.



A SHORT WAVE ROTATING BEACON.

Two short wave rotating beacons of the Marconi Company have been erected, one at South Foreland and the other in the Firth of Forth. The aerial and reflecting wires are shown mounted on the carriage which is capable of revolving. During the operation of the beacon the carriage revolves continually and so emits a rotating beam of wireless waves.

the navigator will not look on his wireless bearings as infallible.

Three different systems of directional reception are at present used in ships, *viz.*, the fixed double loop, the rotating double loop, and the single loop. In the fixed double loop system, the aerial consists of two vertical loops in planes at right angles to one another, and the operator rotates a coil in the receiving apparatus. This varies the strength of the signals, and the direction from which they come can be determined from the position of the coil when the signals are at their weakest.

In the rotating double loop system, the aerial itself, which is similar though much smaller, is rotated by the operator who notes its position when the strength of signals is unaffected by reversing, with a switch, the connexions of the loops. The direction from which the signals are coming is determined by this position.

In the single loop system, the aerial, which consists of a small single loop, is rotated, and the direction from which the signals are coming is determined by the position of the loop when they are heard at their weakest.

The bearing obtained by the wireless operator is the bearing of the station relative to the direction in which the ship's head is pointing at the time, and depends therefore for its correct interpretation on the correctness of the compass reading when the observation is taken. All this sounds rather difficult and complicated, but the fact remains that a ship's operator, after a little practice, can give the navigating officer the bearing of a wireless station, or another ship fitted with wireless, within about two degrees, and it is seldom indeed that the navigator is not satisfied with that degree of accuracy.

Aircraft are sometimes fitted with directional receivers, but the necessary economy of space militates against the general adoption of additional apparatus. All important aerodromes are, however, equipped with directional receivers, so that aircraft can obtain their bearing from an aerodrome on request.

It has recently been decided to go ahead with the erection of all-round wireless beacons at various places on the coast. A dozen places have been selected by the authorities concerned, and at five of these the beacons have already been erected and are in operation. These are installed in lighthouses or lightships at Spurn Head in the Humber, Liverpool, the Skerries at Holyhead, Lundy Island, the Casquets and the Scillies. Each beacon has a distinctive call signal which it broadcasts automatically for definite periods at definite times on a 1,000 metres wave which is allocated internationally for this particular service. Ships fitted with directional receivers can obtain bearings from these stations up to ranges of between fifty and a hundred miles. The beacons at Spurn Head and Liverpool also send out submarine

sound signals which, in conjunction with the wireless signals, enables a ship to calculate its distance from the beacon as well as its bearing. The advantage of this from the navigational point of view is obvious, but such stations are, of course, more expensive to instal and operate than the simple wireless beacons.

Present Facilities.

These all-round beacons, as already mentioned, are only of use to ships which are fitted with directional receivers, *i.e.*, at present only fifteen per cent of British ships fitted with wireless, and the rotating beacons, which could be used by all ships equipped with wireless, have not yet emerged from the experimental stage. The only facilities, therefore, available at present for the great majority of ships are those provided by the Post Office coast wireless stations, which were primarily established for communication between ships and the shore, and in addition one station provided by the Admiralty at the Lizard in Cornwall. The Post Office stations are spaced round the coasts so that no ship, however small, in the vicinity of the British Islands can fail to be in touch with one or more of them. All these stations are not, however, technically suited for giving bearings to ships, that is to say, the positions of some of them are such that the bearings given would be unreliable in all directions, the positions having been chosen with a view to communication and not to navigation.

Those suitable for giving bearings are the stations at Wick, Cullercoats, the Humber, Niton, Portpatrick and Malin Head. The first four have been giving bearings for some time, and the last two will be available very shortly. The stations are carefully calibrated every year, and those sectors in which bearings may be unreliable are published for the information of shipping. In any case the operator at the station informs the ship if he considers that there may be any doubt about the accuracy of the bearing, so that unless the ship is told to the contrary it may be confident that the bearing is accurate within about two degrees. When a ship requires its bearing from one of these stations it informs the station and then sends its call signal continuously for one minute. The station, with its directional receiver, notes the direction from which the signals come, and communicates this bearing to the ship. The 600 metres wave is used for this work at all stations, except at the Lizard where the 800 metres wave is employed, and a charge of five shillings is made for each bearing given. If the ship is distant over one hundred miles the bearing cannot be guaranteed as within the usual degree of accuracy, and at night, especially about dawn and sunset, bearings are often not so reliable as in the daytime.

Occasionally, as in some parts of the English Channel, when bearings can be obtained from French as well as British stations, it is possible for a ship to obtain two bearings and so plot its position on the chart at the intersection of the lines of bearing. Last year about nine thousand bearings were given to ships by our coast stations.

Ships fitted with directional receivers can, of course, obtain a bearing from any coast station. In this case the station sends its call signal for one minute, and the ship takes the bearing. A charge of five shillings is made for each one minute period of sending.

Generally speaking, the bearings taken at coast stations are more reliable than those taken in ships. In ships there is the possibility of errors creeping in due to a change in the positions of guys, derricks and the like, there are fewer opportunities for taking check bearings, and there is the possibility of an error arising in having to refer the observation taken to the direction of the ship's head as shown by the compass at the time. On the other hand, a ship can go on taking as many bearings as it likes on a beacon station, and there is, too, the psychological advantage that the ultimate responsibility for the bearing rests with the ship, which after all is chiefly concerned, and not with the shore station, which may not be in a position to appreciate all the circumstances of the case.

Shooting by Searchlight.

CAPTAIN WILKINS'S new book, "Undiscovered Australia" (Benn, 12*s.* 6*d.*), describes an expedition made into the wilds of the continent on behalf of the British Museum. The chief object of the party was to collect specimens of the native fauna, and in certain cases the use of a searchlight was enlisted for shooting nocturnal animals. (See our cover photograph.) The adventures met with included a visit to aboriginal tribes who still practice cannibalism, and there are interesting descriptions of their life and customs. In regard to the future, Sir Hubert Wilkins says :—"If use be made of organized and applied science, there is a golden future for Australia . . . the fact that I am the son of a father who was born in South Australia in 1836 has given me courage to draw attention to some things which my countrymen may not be pleased to hear." The book, in fact, is more than a valuable travel record : it forms an outspoken contribution to the problems of a great Dominion.

The Romance of the Beaver.

By Sigvald Salvesen.

Naturalist at Arendal, Norway.

A Norwegian here pleads for the wider protection of the beaver, which in Norway has been saved from extinction by law. Colonies are spreading again throughout Scandinavia where, as in other countries, the beaver may prove under modern breeding methods a source of fur more valuable than hitherto.

BEAVERS inhabited practically every part of Norway in earlier times. They swarmed in the numerous rivers and marshes of Finmarken and Nordland; they were plentiful in Troendelagen, where probably the largest colonies of beavers existed, and even found their way into the backwoods of the eastern parts of the country. Some years ago, during cultivation of a marsh at Tveit, in Aamli, old aspentree logs indented by the beavers' chisel-like teeth were found about three feet below the surface of the ground, and other fragmentary evidence testifies that beavers were plentiful in Norway in ancient times. The old name for the beaver is *Bjor*, which is still used in the parts of the country where the animal survives. Many old names of lakes, farms, etc., connected with beaver are still used, for example, Bjorli, Bjorvatten, and Bjorstem.

A BEAVER LODGE.

The lodge (seen on the right) consists of branches propped in triangular fashion against a tree-trunk and covered with sticks. Part is under water and there are two entrances.

The fur of the beaver has always been in great demand, and in the Customs reports of as long ago as 1300 it was one of the most important of exported furs. Even in the time of the Vikings, beaver fur was exported to foreign countries. The increase in population, the march of civilization, and the needs of agriculture had much to do with the disappearanc of the beaver. As the lodges, tracks, dams, and other results of their cutting and digging operations were visible, the beavers' houses were easily found and the keen little dam-builders trapped or killed. Gradually they disappeared from the woods of Norway. In about 1750 they were extinct in many districts and everywhere decreasing in number. The last beaver in Finmarken was killed some seventy years ago, and in Nordland in 1865, while perhaps epizootic diseases also had something to do with their decrease in numbers.

The last survivors comprised a few colonies left in the south-eastern part of the country, especially in Aamli along the River Nidelven. In 1883, when the late Professor Robert Collett of Oslo realized the danger of the beavers' disappearance from the country, it was thought that only one hundred beavers were left. He therefore called public attention to the fact; and as a result of his efforts the beavers were totally protected in 1899. From that time the animals have steadily increased in number, and are spreading over greater and greater areas. There are now supposed to be 12,000-14,000 beavers in the country, which are to be found in Telemarken, Aust-Agder, Vest-Agder and Rogaland counties, in Telemark in western Norway and in Rogaland in the east. The beaver is still totally protected in the border districts of his domain, but in the central area an open season is allowed in the autumn.

For many years past I have had an opportunity of following the invasion of beavers into new areas. The beavers in Aamli were at first only to be found in the River Nidelven, but gradually they were spreading over a wider area following the courses of numerous rivers, creeks, and streams to the countless lakes and ponds in the woodlands. During the first few years we did not see very much of the immigrants. Now and then one might see foliferous trees cut here

and there along the shores, and twigs and branches cut and transported to the water. The animals apparently hesitated to construct lodges, temporarily living in dugouts in the banks.

One autumn I noticed that a pile of mud and sticks had been heaped up close to the shore, under a big spruce. The sticks were stripped of bark and cut off as if by a sharp knife; the mud must have been taken from the bottom of the lake, as tufts of bottom grass with its roots were mixed with it. A fortnight later the heap was increased to a big dome which stretched several yards both up the slanting shore and below the surface of the water. The cupola was peaked—in vertical section nearly triangular—the base being about three yards and the length possibly six yards. I could see the entrance among the twigs and branches under the water, and was astounded that the work had been finished in such a short time. As there had not been sufficient twigs and branches remaining from the meals, any other old sticks had been used.

THE NORWEGIAN BEAVER.
This photograph, taken by the author, shows clearly the beaver's flat swimming tail and webbed feet.

In order to get a room large enough both for living and eating in during the long winter season, the beavers hollow a cavity out from the inner part of the mudheap. They cut off the sticks and dig out the mud and even the surface of the walls and roof with their forepaws. The entrance to the room runs from under the water sloping more or less as the shore does. The upper part of the room is used as a sleeping room, the bed being made of grass and shredded wood. When eating, the beaver sits close to water so that he may wet the food before eating it; only in winter he eats in the lodge. He then takes the food from the pile of twigs and branches of foliferous trees placed in front of the hut late in the autumn; and having gnawed the bark off the sticks, he takes them out of the lodge.

A BEAVERS' VICTIM.
Large oak tree in Hansesdal cut almost through by beavers.

As the family increases, more room is essential. In this case more sticks and mud are placed all over the outer sides of the lodge and the inner room made greater. As a rule the youngsters keep to their home lodge until their second or third year. There may therefore be several inhabitants in one single lodge, since the beavers pair for life and exhibit much devotion to each other.

The beaver sometimes does not cut a tree but only blazes or marks it with his teeth. This is probably done to test the condition of the bark, to see whether the tree is ready for being cut and stored. Large trees are cut in the shape of two pencils standing against each other. The beaver is very fond of the roots of water lilies, although aspen seems to be a favourite food, preferred to all other timber. I have seen aspen trees up to one and a half feet in diameter and fifty-six feet high cut down and all but the trunk utilized for food or building. The smaller trees are usually "logged up" and transported; the animals taking a portion and dragging it between their forelegs, with the result that regular transport roads are often formed.

In Nissendal a pair of beavers I observed had built their lodge only a little over a hundred yards from a farm. Unfortunately the beavers found that the apple trees in the orchard were splendid food; and they cut down several in one night, some of them standing only five yards from the farmhouse. In places where little foliferous trees are to be found, it is good policy to plant plenty of willows, which grow very rapidly. The beaver very seldom cuts down small acicular trees, and then only when they obstruct his way or when he uses them for building. Where the lodge lies in a suitable place, one may feed the beavers with turnip, potatoes, etc., as a supplement.

Late in the autumn, just before the frosts begin to be severe, I have noticed that nearly all the surface of the hut had been covered with fresh mud. During the summer, much of the old mud had been washed away by rain, and now the clever little house-builders laid on a new cover. When this was frozen, it was an excellent protection against cold and possible enemies that would try to reach them in their warm nest. When deep snow covers the ground, it is very difficult to see where a heaver family has its home. By examining the top of the dome, slight traces of steam might perhaps be seen rising from the top in the cold fresh air. Beavers can swim considerable distances under the ice, their lungs being of large size to retain air for several minutes, so that the entrance in the ice where he takes in food may be a long way from the lodge. They have a splendid appetite during the winter; for in the spring white sticks, the remains of the winter's feasts, can be seen floating all over the ponds near the lodges. Earlier in the spring, these sticks can be seen close under the ice.

BEAVER DAM IN HANSESDAL.
The sticks and turf are closely fixed with the aid of mud from the bottom of the stream. A beaver lodge is seen behind on the left.

The most striking work done by the beavers is the construction of dams, which can be seen in many places in southern Norway. I have followed the construction from the beginning in several places. One of the most typical I found was in Hansesdal, a remote valley stretching to the north-west, just below the Suplandsfoss waterfall by Simonstad in Aamli. A very small stream flows down the valley from some marshes farther up. Many kinds of foliferous trees suitable for beaver food were growing on high hillocks on each side of the valley. Although there was no pond in which the beavers might build their lodges, they knew how to manage affairs! By taking up mud from the bottom of the stream and mixing this with sticks and turf they made a dam across the valley. The dam followed suitable points of support as big stones, trees, etc., so that it zigzagged along its course. The top of the dam was so even that the water overflowed evenly along the whole length. As soon as the dam was ready, the animals began constructing a lodge on a suitable place in the pond. Some years later, all the foliferous trees around the pond were eaten, so the beavers abandoned the locality, and some of them went up and some down the Hansesdal to found new "cities." The beavers returned there, repairing the dam and lodge, when new wood had grown up round the old pond.

The beavers often construct two or three smaller dams below the main dam. The surface of the water in that nearest to the main dam rises above the bottom of that dam, and similarly that in the second above that of the first, etc. This, I suppose, is done because the animals know that in flood times the water running over the top of the main dam would undermine it.

The little teal (*annas crecca*) apparently finds a good living in the beaver ponds, as I have very often found this little creature swimming around in the brown, muddy water eagerly searching for food. There are plenty of larvae, toads, etc., in the calm water of the pond. Also the blackbird is often to be found around the pond, and I have noticed sometimes that the bird has given its warning cry before the beavers have seen me coming. But then the beaver promptly gave his warning splash.

As a rule the beaver is very shy and hides in the water as soon as possible when frightened. In places where he is much disturbed, he therefore only works at night. When repairing the dam, they have a watchman on the top while the others are working, who if frightened at once jumps into the water, making the warning splash. The other beavers immediately dive and make for the lodge, or lie under the water, with the nose only above the surface. In this position they are nearly invisible.

Many stories could be told about the beavers' astonishing engineering undertakings, which are so remarkable that one would not think an animal capable of them.

The beaver, in fact, is such an interesting animal that it should be preserved in every country where it is to be found. In olden times the beaver inhabited a very great area in both the old and new worlds, but as the land became cultivated, they became nearly

extinct. No one cared for this interesting little animal and they were not considered game worthy to be protected. For example, in their book "Die Saugetiere" about the beaver, the German zoologists, Carl Vogt and Friedrich Specht, say :—"Except in isolated rivers, where fanciers of these animals have given a sanctuary to some small colonies, the beaver is *fortunately* quite eradicated all over the cultivated Europe. No doubt, some authors have set up sentimental lamentations over its extermination. However, it must be admitted that the beaver is one of the most harmful creatures to the woods, and we need indeed wood materials more than beaver skin and castoreum!" Fortunately the opinion has now altered in most countries in favour of preserving nature and wild life. Of course, beavers cannot inhabit places where the country is much cultivated, since they may do great harm to property. The beaver can, however, easily be kept within certain areas, as he is an easy prey for skilled trappers. In the more remote areas of woodland it would no doubt pay to keep beaver colonies for producing fur.

Both in the United States and Canada beaver farming is steadily increasing. In Norway also several attempts have been made to transplant beavers to the northern part of the country, and many have been sent to Swedish national parks, where they are multiplying fast. With the modern methods of breeding fur-bearing animals, the beaver in the future may become a more common animal in several countries than at the present time. People will learn that it is not economical to exterminate this interesting animal which adds romance to the woods, and can also pay a good rent in the shape of fine lasting furs.

The Future of our National Collections.

By E. N. Fallaize.

Honorary Secretary, Royal Anthropological Institute.

After dealing with the main issues now before the Royal Commission, which are of first importance to public education in its widest sense, Mr. Fallaize discloses plans for the future of our ethnographical collections. Specimens are becoming rarer day by day before the advance of European civilization.

It was at one time almost an article of faith in party politics that any inconvenient question might be most expeditiously and effectively buried by the appointment of a Royal Commission. It is devoutly to be hoped that a kinder fate may attend the problem of our National Museums and Collections upon which a Royal Commission has been sitting since the summer of 1927. Although the Commission has not yet reached the end of its deliberations, it has recognized the extreme urgency of some of the questions which have come before it by issuing in September last an interim report.

The Commission was appointed by Royal Warrant on 1st July, 1927. It consisted of Viscount D'Abernon, Chairman, The Hon. Evan E. Charteris, Sir Thomas Little Heath, Sir Lionel Earle, Sir Richard Glazebrook, Sir George MacDonald, Sir Courtauld Thomson, Sir W. Martin Conway, Sir Henry A. Miers, Sir Robert Clermont Witt, and Dr. Arthur E. Cowley. It will be agreed that the Commissioners formed a strong body, covering a wide field of interest and specialized knowledge. This was demanded both by the variety of institutions in England and Scotland which had been included under the category of "National," and by the terms of reference.

The institutions under review were nineteen in number, or rather twenty, as the Scottish National Galleries are really two separate institutions. They included the British Museum and the Natural History Museum, the National, Portrait and Tate Galleries, the Record Office, the Victoria and Albert, the Bethnal Green, Science, Geological, London, and Imperial War Museums, the Botanic Gardens at Kew, the Wallace Collection, and in Scotland the Royal Scottish Museum, the National Galleries, the Scottish Museum of Antiquities, the National Library, and the Record Department of the Registry House.

It is evident that even to obtain a knowledge of the varied contents and the working of these institutions was a formidable task; but when the terms of reference are considered it must seem truly remarkable that the Commission should be so far advanced as even to publish an interim report after sitting for only a little over a year. In justifying its action on the ground of the delay that must supervene before the final report can be issued, the Commission is guilty of no exaggeration.

The terms of reference covered in the first place the legal position, organization, administration, structural condition of buildings, and cost—that is, clearly, cost of maintenance—of the collections. By this was meant of the collections as they stand, for

the Commission was asked next to enquire into the rate of growth and consequent increase in expenditure during the next fifty years if present practice is continued. At the same time the possibility of economies without detriment to the institutions was to be considered, as well as the question of a charge for admission as a source of income. Further, the question of the arrangement of the collections and their distribution and of congestion had to be taken into account, and whether specimens either of slight importance or in excess of requirements might be disposed of by sale or by loan to other institutions.

In addition, certain limitations and legal requirements, of which the public has heard from time to time as the cause of difficulty, were mentioned for consideration. The provision of the Copyright Acts, whereby the British Museum receives for preservation a copy of all publications seeking the protection of the Acts, has frequently been cited as a cause of much expenditure of time, storage space, and money, in the Department of Printed Books. The bequests of benefactors, especially to the National Gallery, have also sometimes interfered with what has been felt to be the most effective and appropriate allocation for exhibition and study.

The Commissioners were required further "to make recommendations generally which may suggest themselves as pertinent in the light of information obtained during the course of the enquiry."

From the terms of reference two points emerge. Firstly that there was no doubt in the mind of the authorities responsible for finance of some hope of possible economies in the upkeep of the national collections as they stand at present, and secondly that there were certain questions relating to these collections which needed ventilation.

The Problem of Congestion.

It has long been known to a fairly wide circle, which is keenly interested in the national institutions and anxious that the greatest possible benefit should accrue to the public from what are its possessions, that all was not well with them. No one was more fully aware of this than the officials themselves to whom they are entrusted. Apart from the fact that museums and galleries are by no means adequately staffed, in particular they suffer from congestion. This is perhaps their most serious problem. The exhibits are overcrowded, nor are they displayed to the best advantage, either aesthetically, scientifically or educationally. What is more, a great deal of valuable material is not shown at all and cannot even be made accessible to accredited students. This has been fully brought home to the Commissioners. It is owing to the urgency of the problem that an interim report has been published which deals largely with the question of accommodation.

From many points of view the British Museum presents the most serious problem, especially as regards the Library. The Natural History Museum has strong claims on the ground of the necessity of more adequate space for scientific arrangement, and as has been emphatically pointed out by the Royal Society, provision for research workers is urgently needed. Of the South Kensington collections, in the view of some authorities, certain sections should be entirely reorganized, especially in connexion with Indian exhibits. It is unnecessary to go through the list. Nearly every one of the collections here considered has a strong case to urge.

Extension Schemes.

Of the London institutions, several have schemes of extension in readiness. The National and Portrait Galleries should ultimately occupy the vacant spaces at the rear of the existing buildings, taking up the whole of the block to the north of Trafalgar Square. The British Museum also has a scheme of extension, and has already attempted to cope with the difficulties of the Department of Printed Books by a Repository at Hendon, to which the Commissioners now suggest that the whole of the newspaper and periodical section should be transferred.

All these schemes have been under review by the Commission. It is pointed out that their cost would be considerable. Accordingly alternatives are suggested in the Interim Report which could be effected at a considerable saving, say, not less than at £800,000. It is estimated that the needs of the National collections for the next fifty years could be met by a provision of £779,000, spread over a term of twelve to fifteen years, and involving an average annual expenditure of £52,000, which would not exceed £130,000 in any one year. Relatively to our annual national expenditure this seems a small amount; but it must be realized that the need for immediate action is very great. It is not possible to deal here with arguments in detail, but there is one point which calls for mention.

It has been suggested that the British Museum might be allowed to deal with the difficulty of storing printed books and periodical literature imposed upon it by the Copyright Acts by a system of selection. The Commissioners do not view this proposal with favour. A staff of expert selectors would be required whose salaries would absorb any possible economies, while it is justly pointed out that it is impossible to

forecast that any item may not become of interest or be required in the future. The value of chapbooks and broadsheets at the present day, not merely as antiquarian curiosities, but as documents in social history, may serve to support this view.

Although the Commissioners in the Interim Report have as their main subject the question of accommodation, they cover a great deal of ground which is of more general import. This is not irrevelant, however, for it has a very direct bearing upon the question of cost involved in any suggested extension. Taking the institutions one by one, the Report outlines their history and shows how greatly the nation is indebted to private benefactors and to private initiative for these great collections which now are of almost incalculable value and one of the greatest of the assets in our national wealth. The British Museum, as is well known, began with the bequest of Sir Hans Sloane, from whose trustees it was purchased under the terms of his will for, at the most, a quarter its money value. With the Sloane collections were incorporated the Cottonian and Harleian manuscripts and documents, originally the property of private individuals. In the same way the National Gallery, the Tate Gallery, the Wallace Collection, the National Library of Scotland, and the Scottish Museum of Antiquities, to name some only, arose out of private enterprise, while the collections at South Kensington were due to the foresight and keen interest of the Prince Consort. Nor is this private benefaction a matter of the past only. During the last five years the value of private gifts to the British Museum has been in the neighbourhood of £40,000 a year, as compared with the purchase grant of £25,000, and in the Victoria and Albert Museum the annual gifts have averaged £24,000, as compared with the purchase grant of £16,000. Further, the buildings of the Tate Gallery, the National Portrait Gallery, the London Museum, the Scottish National Portrait Gallery, and the Scottish Museum of Antiquities, have all been provided by private individuals. To put it colloquially the nation has had a bargain. For how does its contribution compare with that of the private donor? Economy has been pushed to the point of endangering efficiency.

National Education.

The Commissioners point out that whereas one hundred years ago subventions were already being given to such national collections as existed at that date, such as the British Museum and the National Gallery, grants in aid of elementary education were not made until 1832. Yet now the museums, as the Commissioners put it, are "the Cinderella of the social services." Nevertheless it is recognized that these institutions perform a function of the highest importance in the national system of education and their utility could be very greatly extended. The British Museum "has probably done more for research, for the advancement of learning, for the study of civilization and of science, than any single institution of its kind at present existing in the world." Yet, on the other hand, "it is difficult not to feel, whether from the standpoint of material or of spiritual values, that the immense capital represented by the national collections is not bringing in the maximum return."

Proposed Ethnographic Museum.

In dealing with the needs of the institutions under review, the Commissioners have purposely reserved the question of the ethnographical collections in the British Museum, but they quote with approval the opinion of the Council of the Royal Anthropological Institute which emphasizes the lack of an Imperial Ethnographic Museum, and points out that ethnography "is given less attention in the capital city of the Empire than it is in countries which have far fewer responsibilities or even none at all towards uncivilized or alien peoples." It is proposed to revert to this matter in the final report. It may not be inopportune, however, to point out that the question is far broader than might be gathered from the reference in the Interim Report. It is not merely a question of the arrangement of the existing collections and provision for storage and additions. The need is more urgent. For one thing the period of time during which it will be possible to collect specimens is by no means unlimited, they are becoming rarer day by day before the advance of European civilization. What is needed is a museum devoted primarily to the study of the races of the Empire, though not confined to those races in view of the requirements of comparative work. It should not be regarded merely as a museum for exhibits illustrating the culture of our primitive peoples. It should make the fullest provision for research and above all for practical instruction, especially for the instruction of administrators and officials of the Dependencies. The provision for the practical side of the training in anthropology of administrators of the backward races in the Empire is virtually non-existent—certainly in London. If such an Imperial Museum were established, it is perhaps not indiscreet to mention that for its teaching and research department the nation might once more be indebted to the munificence and initiative of a private individual who is well known as an archaeologist keenly interested in ethnographical collections.

Daylight and Bird-Migration.

By V. C. Wynne-Edwards, B.A.

New experiments undertaken in Canada are investigating the relation of daylight and bird-migration, an aspect of the problem that has hitherto received scant attention.

PRACTICALLY all we know about bird-migration, except of the mere comings and goings, has been discovered in the last fifty years. For the latter half of this period interest has centred on what may be termed the geographical side, the "where" and not the "why" or "how," principally owing to the development of the marking method, introduced in this country about 1890, and ably developed by the German *Vogelwarte* at Rossitten, by Aberdeen University, and by the journal *British Birds*. With this began the era of direct experiment. Previous speculation advanced furthest along the "why"-branch, but it is only quite recently that this has been made susceptible of experiment also. These experiments are highly important, but at present bird-ringing so occupies the field that they have scarcely been noticed, let alone absorbed, by ornithologists.

The Reproductive Cycle.

Migration forms a part of the reproductive cycle of migratory species. It is characteristic of the northern hemisphere, being found in the southern only to a very limited extent. This is probably due to the almost entire absence of land in the southern temperate and sub-Arctic regions. It is rhythmic and annual: towards higher latitudes from lower in spring, and *vice versa* in autumn. That this is an echo, maybe distant, of the similar apparent movement of the sun through the zodiac is evident; and from this follows the idea that the ends served by migration may have something to do with the length of the day.

The most arduous part of the reproductive processes, even including migration itself, is the feeding and rearing of the young. Where the parents undertake this, as among the Passeres, the birds are said to be nidicolous; and where the young are hatched in an advanced stage of development, ready to leave the nest almost immediately and fend for themselves or under parental guidance, as among the waders (*Limicolae*) and game-birds (*Galli*), they are termed nidifugous. Whether nidicolous or nidifugous the growing chick requires a practically continuous supply of food from dawn till dusk, and in many species extensive territorial arrangements are made to allow of its more speedy collection. For this reason the greater length of the day in the breeding season in high latitudes is of the utmost benefit to the species. Mr. Savage English has recently shown that among the majority of nidicolous birds in this country clutches average a little over five, and species that lay two or three eggs are exceptional. Here the May-June day-length is from seventeen to nineteen hours; while in the tropics, where it is always about thirteen hours (allowing for the short twilight periods), the exceptions are those species which have more than two or three eggs. In noticing the latter he shows that the tropical woodpeckers, for instance, can obtain practically unlimited food by just tapping at the mouths of the termite burrows to set the stream going, and can thus support a large number of nestlings without difficulty; and, on the other hand, the northern nightjars, which lay only two eggs as a rule, are nocturnal. It appears that birds are limited in the size of their clutches not by their physiological ability to produce eggs, since many species rear more than one brood, but by their physical ability to supply enough food to their young in the given time, which is usually whilst the daylight lasts.*

A Neglected Study.

The idea that daylight has anything to do with migration has been curiously neglected. Ornithologists from the time of Aristotle to the present have sought to find an explanation in the weather, and more particularly in temperature changes, their theory being that in spring the birds fly north to avoid the coming heat, and in autumn they return to avoid the coming cold. The latter tenet may be criticized as being teleological; but to speak of the "coming heat" in the tropics, where seasons are differentiated only as being wetter or drier, or in the southern temperate regions on the verge of winter, is ridiculous. The Swedish poet Runeberg (1804-1877) appears to have been the first to connect daylight and migration in his suggestion that the birds' motto should be *lux mea dux*, and his view was published in *The Times* in 1874. At the same time there appeared some merely fantastic theories, one of which supposed that migrating birds

* In nidifugous species the number of eggs which the parent can cover and keep warm is, of course, a limiting factor.

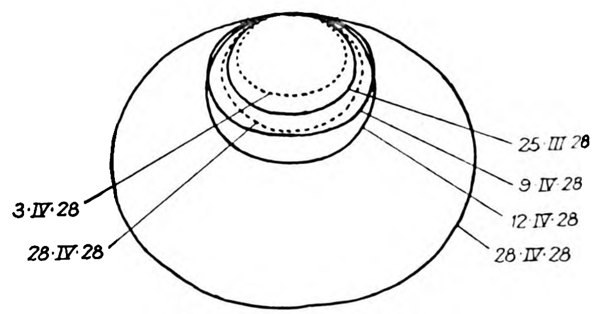
were caught up in a vortex and carried involutarily in the upper strata of the atmosphere. Prof. A. Newton, throwing away the baby with the bath-water, quashed the whole lot in a letter to *Nature* (1874). In dealing with the former he confused the motive, to which Runeberg referred, with the impulse or stimulus to migration, when he pointed out that its great fallacy was this, that in autumn many species not only start their southward migration, but in some cases complete it, before the equinox, and are thus moving into shorter and shorter days the further they go. *Mutatis mutandis*, the same is true of the spring also. If a bird seeks the longest day available within its range of latitude, why does it start to move before the equinox? This question was again raised by Schäfer (1907).

That migratory species benefit by the long summer days of high latitudes is sufficiently clear. No explanation is given, however, of the actual stimulus or series of stimuli which sets them off. A review of the literature on the subject has been given recently by Prof. Rowan (1926), who has been able to support his views by direct experiment up to a point conclusive. The clockwork regularity of arrival of migrating birds, which is more readily detected than their departure, does not appear to be correlated with temperature changes, for the weather at the same time is sometimes cold and often stormy. It may be argued that many species start further south on their northward migration, and are thus not under the influence of our variable climate, but encounter it when the pendulum is already swinging; yet there are others, for instance, the fieldfare, which winter with us, whose departure is none the less regular. Indeed, the only physical cycle which is sufficiently stable to serve as a basis for migratory stimuli is the waxing and waning of the day, which, being astronomical, is independent of the vagaries of terrestrial phenomena.

On this premise both Schäfer and Eifrig (1924) have advanced similar theories, namely, that the changing day-length is directly responsible for the initiation of migration each year. This has come to be known as "photoperiodism." Schäfer was alive to Newton's objection mentioned above. There are, too, other equally cogent reasons why the photoperiodic theory is unsatisfactory in this simple form. For one, in the tropics the day-length does not change; and for another, further south, for instance in South Africa where the swallow winters, the day-length is changing the wrong way, getting shorter instead of longer when the birds start north.

Rowan has introduced the idea of rhythm into the theory of photoperiodism. Man, like the barn-door fowl, has lost almost all traces of (annual) reproductive rhythm, and is thus not sufficiently reminded of its almost universal presence in the remainder of the animal and plant kingdoms. Cases are known where, though the stimulus be removed, the rhythm may still continue for a time, though not indefinitely. For instance, certain trees when transplanted to the tropics will go on shedding their leaves at the usual season, adding annual rings to their wood, for a period of years, till at last the rhythm is lost, and leaves may be falling from one branch at the same time as buds are opening on another. The lunar periodicities of spawning of the marine Turbellarian worm *Convoluta*, which persists for some time indoors in an aquarium, and of the Palolo worm, are mentioned in every popular work on zoology. The rhythm is that of a flywheel, which, though it carries considerable momentum, slows down ultimately unless some motive force is from time to time applied. It is the express purpose of a flywheel to carry the movement on between successive explosions in the cylinder; and, maybe, in the case of migration the rhythm is carried on between successive periods of subjection to the stimulus of changing day-length. Once the possibility of an established rhythm, inherent in the bird, is grasped, many of the chief obstacles fall to the ground.

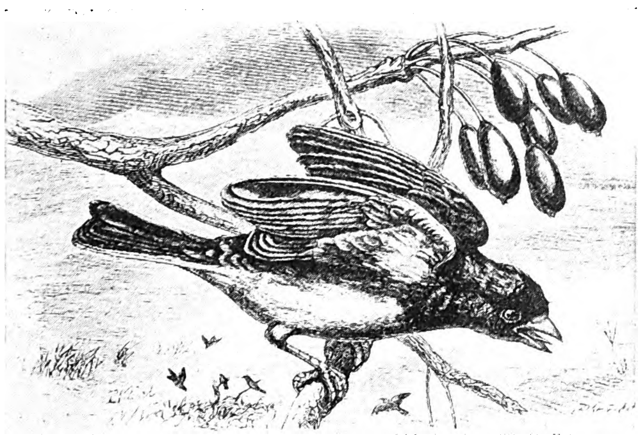
A rhythm of this kind is the result of an internal physiological mechanism; so that tracing the annual initiation of migration to photoperiodism is only a step towards the discovery of the real stimulus. Recently work has been done by Rowan and is still in progress to find the effect of light on the development of birds' reproductive organs, and it appears to be yielding most fruitful results. These experiments have not yet had time enough to be repeated by other workers or to be substantiated in a scientific manner; consequently further work may necessitate a considerable revision of our present theory. The main principles, however, appear to be fairly secure.



REPRODUCTIVE DEVELOPMENT.

Diagram of the relative sizes of the male reproductive organs of experimental and control birds, showing how those in birds artificially kept awake developed far in advance of normal. Dotted lines and left-hand dates refer to controls; black lines and right-hand dates to experimentals. (From Rowan, by courtesy of *Nature*.)

The reproductive organs (or gonads) of birds undergo an annual cycle. In winter they are relatively small, maturing and increasing rapidly in size towards the breeding season, after which they shrink slowly to their winter minimum again. In the females the presence and size of the ovarian follicles is an indication of ripeness. Rowan, working in Canada, trapped Juncos on their autumn migration and put them in cages. One cage was illuminated for increasing periods after sunset so that the occupants were artificially subjected to increasing lengths of day. The other was kept under natural conditions as a control. Some birds from each cage were liberated from time to time, and others were examined for their state of maturity. By early autumn the winter minimum of size was reached by the gonads of the experimental birds, and, although control birds flew away on liberation, these experimentals returned to the cage.

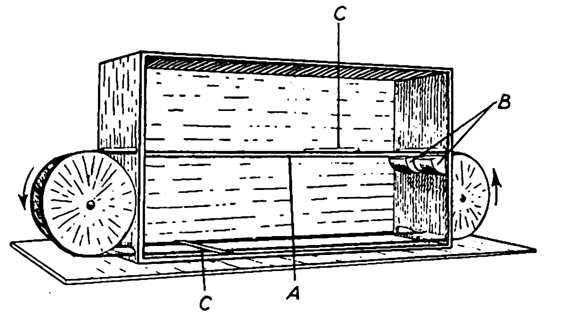


THE JUNCO OR "SNOW-BIRD."

The *Junco hyemalis*, which breeds in sub-arctic Canada, and is a winter visitor to the United States. It was used by Prof. Rowan in his experiments at Edmonton. (From Wood's "Illustrated Natural History." By courtesy of Messrs. Routledge.)

From this it appears that birds whose gonads have reached the winter condition no longer desire to migrate, although the season for doing so is still appropriate, as witness the departure of the controls. Later the gonads of the experimentals started to increase, while those of the controls were still diminishing with the approach of winter; so that by the time the earliest wild juncos began to arrive in spring the gonads of the experimentals were appreciably larger than those of their wild congeners.

It is difficult to see how daylight could directly effect changes in an internal system of the body. Further experiments in 1928 were therefore made to find out whether increasing activity, brought about by the daily extension of the waking hours, was the direct cause of the development of the gonads. These were most ingenious. The cages, instead of being



PROFESSOR ROWAN'S EXPERIMENT.

Experimental cage in which the Juncos were kept awake by making them hop over a bar C which sweeps through the cage on the travelling belt A. (From Rowan. By courtesy of *Nature*.)

illuminated, were covered up at the same time each day so that the day-length remained constant; and the birds were *kept awake* for increasing periods after dark by contriving that they should have to hop over a bar fixed to an endless band revolving on two drums outside the cage, which swept the perches every twenty seconds, so that a bird caught napping would be tumbled over. This was in March and April when the gonads were normally maturing. Every three weeks a sample was taken from both experimental and control cages (which were also darkened to keep the day-length uniform); and whereas the gonads of the latter showed practically no change in size, those of the former developed relatively enormously in a short time.

This interesting investigation shows how altering day-length might afford the stimulus to migration by increasing the daily period of activity, which in turn is correlated with the increase in size of the gonads. Although it is very plausible that the recrudescence of the gonads should stimulate migration, this is the weak link in the chain. It might be found, for instance, that a hormone from some other gland was proliferated at the same time and for the same reason (increased activity), which was ultimately responsible for the phenomenon. At all events, it illustrates how complex a series of events may be involved in the annual initiation of migration.

It is noteworthy how easily the reproductive rhythm may be upset in the Junco. Evidently it is not inherited. In other species, for instance, trans-equatorial and intra-tropical migrants—of which more will be said below—the rhythm must be inherent since the increasing-activity stimulus is inoperative. Parallel illustrations may be taken from the plant kingdom. The Junco may be compared to the plant Hydrangea, which as is well known will produce blue flowers, instead of the usual pink ones, when it grows

in a soil rich in iron salts. It is not the blue flower that is inherited, but the aptitude for producing blue flowers upon being suitably stimulated. So with the junco, it is not the annual reproductive rhythm which is inherited, but the aptitude to reproduce. The stimulus is essential. The other species mentioned may be compared to white heather, for example, which always produces white flowers under any conditions, for with them the rhythm appears to be inherited *in toto*. Open-mindedness upon the question of how much of the great reproductive instinct is inherent, and how much is acquired anew every year, is essential to the investigation of this problem. Just as there is every degree of migration from the local movements of species like the English robin to that of the curlew-sandpiper, which travels practically from pole to pole, so it may be expected that the degree to which the instinct is heritable will be subject to great variation also.

Certain exotic species (*e.g.*, the Mexican swallow, *Progne*), migrate annually from the forests to the mountains to breed, without leaving the tropics at all, though the majority of native tropical birds are stationary. In this case daylight cannot be the basis of the migratory impulse; yet a rhythm is developed, and the journeys appear to be made at the same time each year. At present it is impossible to reconcile this with the photoperiodic theory. The flywheel appears to be endowed with perpetual motion.

It might be questioned whether the long northern summer day is of any value to nocturnal birds. Indeed at first sight it seems to be directly inimical to their habits; but in those groups in which migration is well developed, as it is in the nightjars (*Caprimulgi*), the birds are not truly nocturnal but crepuscular, feeding in the twilight, thus gaining enormous benefit from their sojourn. Owls, on the other hand, which feed actually in the night, are for the most part non-migratory.

Whatever its present limitations, photoperiodism is a subject to be commended to all naturalists. Recently a review in *Discovery* claimed the theory as original, which illustrates the scant attention paid either to the recent developments of the theory, now partly substantiated by Prof. Rowan's experiments, or indeed to the theory at all.

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Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

THE FACE OF THE SKY FOR NOVEMBER.

SEVERAL planets are on view during this month. Jupiter takes the leading place, being above the horizon nearly all night. Mr. B. M. Peek and Rev. T. E. R. Phillips reported an interesting development on the planet in August and September; a curiously shaped marking between the south equatorial and south temperate belts expelled a number of small dark spots, which proceeded to move westward on the planet's surface, keeping near the edge of the south equatorial belt. Their speed was 120 miles per hour, which gave a rotation period of 9 hours 59 minutes; this is the longest ever recorded for markings on the planet; the outbreak also produced a disturbed region on the edge of the belt, which moved in the opposite direction, but at a much slower rate. These phenomena demonstrate the intensely active forces that are at work in the Jovian atmosphere.

Mars is now approaching opposition, and is stationary on the 12th November near the third magnitude star Epsilon Geminorum, which affords an excellent point of reference for studying the planet's movements; these are first towards the east and then towards the west. On the evening of 18th November the planet is only 17 minutes (that is, little more than half a moon's breadth) to the south of the star. It is approaching the earth, being 69,000,000 miles distant on 1st November, and 56,000,000 on 30th November. The least distance, 54,000,000 miles, will be reached in mid-December.

Mercury and Venus.

Mercury may be seen as a morning star about 9th November; it is in Virgo, not very far from Spica, and rises nearly two hours before the sun. Venus may be seen in the early evening, low down in the south-west. It is near the moon on the evening of the 15th. It will be better placed in the following months. Uranus also is now easily observed, being due south at half-past 8 p.m. in the middle of the month. Its right ascension is then 0 hours 15 minutes, north declination 50 minutes. The nearest

naked eye star is 44 Piscium, which is over a degree to the north-east of it. A chart of its path among the stars is given in the B.A.A. Handbook for 1928.

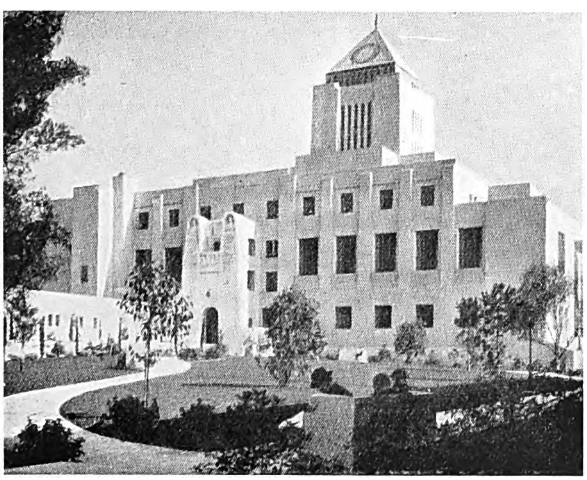
A partial eclipse of the sun will be visible in the British Isles on the morning of 12th November. In London the eclipse begins at 7.40 a.m., the greatest phase, about one-fifth of the diameter, is about 8.28 a.m., and the end at 9.18 a.m. If we go back six Saros cycles we come to the annular eclipse of 1820, 7th September. Nine-tenths of the sun were then covered in England. The central line crossed the Zuider Zee, also Lugano; Wordsworth saw the eclipse there, and refers to it in one of his poems.

The eclipse is slowly diminishing at each return; the greatest phase is now eight-tenths, in north Siberia. Notes on several of the eclipses of this cycle will be found in Johnson's "Eclipses Past and Future."

There is a total lunar eclipse on the morning of 27th November. The moon sets in London a few minutes after first contact with the umbra, which is at 7.24 a.m., but the smokiness due to the penumbra may be seen some minutes earlier. In the north-west parts of the British Isles a good deal more of the eclipse will be seen.

Many amateur observers now note the times of occultation of stars by the moon; Professor Brown has found these observations of great use in determining the errors of the moon's place as compared with his lunar tables. Those who wish to observe them regularly should obtain the Nautical Almanac, or the Handbook of the British Astronomical Association. The brightest star occulted during November is 30 Piscium, magnitude 4.7, which will disappear for London observers at 5.43 p.m. on 22nd November. To be of any use the times of disappearance of stars must be noted to the nearest second, the exact error of the clock being found from the wireless time signals.

There are two well-known meteor streams that the earth intersects in November; the Leonids, whose radiant is in the Sickle of Leo, about 14th November; and the Andromedids, the relics of the lost comet of Biela, about 18th November. Their radiant is near Gamma Andromedae. The search in each case may extend a few days before and after the date given. There were very rich showers of Leonids in 1833 and 1866, but there was disappointment in 1899, the action of Jupiter having diverted the richest part of the swarm from the earth's orbit.



NEW PUBLIC LIBRARY AT LOS ANGELES.

Book Reviews.

Further Impressions of the Public Library System of the United States of America. By K. E. Overbury and E. E. Lowe, B.Sc., Ph.D. (Published gratis by the Carnegie United Kingdom Trustees, Dunfirmline.)

These impressions of two English delegates, Miss K. E. Overbury from the West Riding of Yorkshire and Dr. E. E. Lowe from Leicester, who attended the conference of the American Library Association in Toronto in 1927, are written as addenda to those of six delegates to a previous conference. Their enquiries and observations show that the libraries are everywhere playing a great and growing part in the active educational system of America, besides giving endless service to those who have passed beyond its immediate influence.

There appears to be a spirit of friendly rivalry between the States, and cities within them, in their efforts to build up and endow the most palatial and efficient library. The enterprise of the American Library Association and the munificence of individual benefaction, for which America is famous, must not be overlooked in this survey of the resulting system. The staff of the great majority of the libraries visited was almost wholly composed of women, and every comfort was provided for a very adequate staff as judged by English standards.

The results of America's greater expenditure on the education of each individual child, compared to other countries, is shown in the fact that in most, if not in all, schools there is some kind of library. This school-library may be run entirely by the school board but in the majority of cases it is run as a section of the local public library; or there is a very close co-operation in those cases where the public library is situated in the school buildings—the main library then being separate from that of the school, but allowing the school children many advantages of the town library which would otherwise be unobtainable.

Another feature in the regular work of many American libraries is the arranging of "story hours" for children in the library itself—and a series of talks to all school-children on the attraction and advantages of the local collection of books. This work in the school is followed by active assistance given to the adult reader, the American Library Association issuing handbooks in a "Reading with Purpose" series, which results in a necessary duplication on a large scale of popular current volumes but which does ensure that the general public are regularly informed.

Although one quarter of the population are enrolled members of the local libraries, there are large areas including a population of 45,000,000 which still remain without any local library provision, these mainly in the rural districts. On the other hand, owing to the small centres of population and other considerations, service "by contract" is frequent. Thus legislation exists whereby (i) a county library service may be secured by contract with an existing city library or libraries: in some States contract service is the only one authorized where a public library is in existence; (ii) counties may contact with each other for a joint service; (iii) a city library may become the centre of a county system. Furthermore, American libraries possess special facilities for lecture-work and club activities which are unknown features of the English library system—and utilize to the full the organ of press publicity to ensure that the system is fully used by the general public.

That this comparison between the American and English Library systems is constantly in the minds of English librarians

was seen at this year's Oxford conference of the Library Association, where several speakers emphasized the progressive and up-to-date American methods.

South Africa's Past in Stone and Paint. By M. C. BURKITT. (Cambridge University Press. *12s. 6d.*).

Although it is notoriously unsafe to prophesy, there is little risk in saying that for future generations Mr. Burkitt's "South Africa's Past in Stone and Paint" will mark an epoch in study of the prehistory of that great sub-continent. Books—authoritative books—have been written about South Africa's Stone Age by South African archaeologists; there are authorities on the stone implements of South Africa in this country, notably Mr. Henry Balfour of the Pitt-Rivers Museum. Yet South African writers, however intimately they knew their own material, did not, indeed could not, possess the close acquaintance with the prehistory of the north—both Europe and Africa—necessary for detailed comparative work. Mr. Balfour, wide and profound as is his knowledge, has been interested in specific problems in typology, touching upon prehistory incidentally as it bore upon his subject, rather than as a main objective. Mr. Burkitt, on the other hand, entered upon the archaeological tour of which he here gives the results at the invitation of the University of Cape Town with the definite object of surveying South African archaeology as a whole. Further, he had as his background an acquaintance with the prehistoric archaeology and early prehistoric sites of Europe which is as close, if not even closer, than that of any archaeologist of the day, excepting only the leaders of the French School.

In the last few years Africa, and especially East and South Africa, have been rapidly taking that place in the study of the history of man which they should hold in view of Charles Darwin's expectation that in this continent we should find man's place of origin. Consider what South Africa has given the anthropologist. There is the occurrence there, now known for some time, of stone implements which in type resemble the palaeoliths of Europe, found sometimes in the geological conditions which appear to resemble those which we expect in association with vestiges of early man in Europe—discoveries for which the antiquity claimed was at first treated almost with derision, but now almost fully accepted. Then there are the Bushman paintings, of which the resemblance to the later palaeolithic art of Eastern Spain is most striking. In this connexion, though not in the same genre, may be mentioned the remarkable resemblance in the physique of the Bushman and the steatopygous ivory female statuettes carved by Aurignacian Man and found in the French caves and elsewhere in Europe. The Zimbabwe, the great structures of brick in Rhodesia, are still an unsolved mystery, neither their date, their purpose, nor their builders being known as yet except by conjecture, though this ranges from Solomon's Sheba to native tribes of only a few hundred years ago. And, finally, of man himself we have the primitive forms of the Boskop Skull, and the Neanderthaloid Rhodesian man who, whatever their date in years, must take an early place in the growth of the human tree, while Professor Dart's *Australopithecus* lays claim to an even more lowly place in the same line.

Mr. Burkitt's readers owe an immense debt to South African archaeologists for the liberality with which they placed their knowledge and their collections at his disposal. He travelled over six thousand miles, visiting numerous archaeological sites and examining quantities of implements in collections, both public and private. He speaks in terms of amazement at the wealth of material which was placed before him. He was specially concerned with two classes of evidence—the stone implements and the Bushman paintings and engravings. These he has surveyed in detail.

Briefly Mr. Burkitt's conclusions are that South Africa has afforded evidence of every phase of the Old Stone Age of Europe from the Chellean industry to the microlithic types which follow the close of the Palaeolithic. This does not necessarily imply that all are contemporaries with these European prototypes. The Chellean *coup de poing*, he points out, may be entirely modern, while some specimens most certainly are. But postulating the Lower Palaeolithic implements as typologically the earliest and as remaining long in isolation, they are followed by industries of Middle and Upper Palaeolithic, with strongly marked signs of local development. For certain of these the author has interesting suggestions to offer which point to possible lines of connexion with the different epochs of Mr. Leakey's remarkable discoveries of the remains and culture of Early Man in East Africa at Elmenteita and Nakuru. In like manner Mr. Burkitt finds a sequence in the art of the Bushman, where he distinguishes an early and a later school which he correlates with certain industries. He has some interesting remarks to make on its possible relation to the art of Eastern Spain and the migration of the Capsian peoples.

Ethnological and linguistic evidence point to a constant migration of peoples into what is now the Union of South Africa, which was still going on up to quite recent times. It is interesting to note how Mr. Burkitt's conclusions bear this out. This country is, indeed, as he says, "a gigantic, wonderfully stocked museum of the past." No one would be less ready than Mr. Burkitt to claim finality for this book; but it has laid the foundations well and truly for the study of South Africa's remoter past.

E. N. FALLAIZE.

The Station. Athos : Treasures and Men. By ROBERT BYRON. (Duckworth. *18s.*).

Readers of "The Monuments of a Millenium" in our columns for October will find increased pleasure in Mr. Byron's full account of the expedition on which his article was based. Nor does it reflect unfavourably on either piece of work to admit that the book provides a freer hand for the author's keen sense of humour, which contributed in no small measure to the success of his unusual venture.

Accompanied by several kindred spirits and amply pro ided with introductions, Mr. Byron set out on a second trip to Mount Athos. "He who formerly visited your holy place," wrote the Œcumenical Patriarch of Constantinople, head of the Orthodox Church, to the Synod of the Holy Mountain, "the learned Englishman Mr. Robert Byron, anxious there to pursue his researches in Byzantine art, comes thither for this purpose, intending particularly to photograph the frescoes of the leading churches. We, therefore, gladly urge . . . that there be afforded him everywhere a courteous reception and treatment," etc. It must be remarked in passing on this impressive document, reproduced with facsimile signature, that the illusion is rather rudely diminished by the Patriarch's reference to the 20th "ultimo," that hall-mark of modern business correspondence; but of the value of his letter there can be no question.

On his first visit to Athos, the author was handicapped by ignorance of the vernacular which he had, however, mastered for the second journey. The consequent advantages are obvious, in these new pages, which tell of many privileges secured by the personal persuasion of certain officials whom the introductions had failed to convince. Many excellent photographs were secured, and Mr. Byron has in preparation a separate volume on "Later Byzantine Painting." He is, incidentally, an artist of no small accomplishment, as well as a practiced photographer.

In connexion with the language there are some outspoken comments on the teaching of Greek in English schools. "Though the average reader of the classics experiences no difficulty in reading a modern Greek newspaper, the pronunciation which he has been taught is one that not only no Greek can understand, but which denies, in addition, that very poetry of sound which Greek literature professes to reveal. Not, however, content with this purposeful obscurantism, the Anglo-Saxon professor, with the nauseating self-sufficiency of his kind, must even blame the native for pronouncing his language in the manner it demands."

Although the reviewer learnt the elements of Greek in the same preparatory school as Mr. Byron, he cannot claim to have pursued it far enough to comment adequately on this indictment of the "professional pedagogue." Suffice it to say that the passage just quoted is typical of many illustrating strong and original views, which in almost every case are supported with evidence and based on a careful study of the subject.

J. A. B.

The Story of the Birds. By C. J. PATTEN, Professor of Anatomy in Sheffield University. (Sheffield : Pawson and Brailsford. 16*s.* 6*d.*).

The material in this volume is based on a series of nineteen broadcast school-lectures delivered by the author from the Sheffield B.B.C. Station. By enriching and weaving their contents rather than by transcribing them the author, aware as he tells us of his own shortcomings, has, to his own satisfaction, made a story sufficiently interesting and instructive to justify its publication.

It is essential that even the amateur ornithologist, if he is really in earnest in the pursuit of his hobby of bird-study, should be able to understand the reason-why of his observations. This he cannot do unless he knows in more than broad outline the structure and function of all the intricate organs of the animal he is observing. To gain this knowledge he must obtain and examine in minute detail the dead bodies of birds of many species, which the author points out can easily be obtained without killing specially for the occasion—dead birds in fresh condition are to be had in plentiful numbers if search is made in the right place.

The technicalities, usually thought to be dry and tedious for the beginner, are dealt with in a manner the very opposite to dull, giving every amateur, who without this knowledge will always remain an amateur, an opportunity to become an "expert" with the smallest amount of study.

The first fifteen chapters deal almost exclusively with avian anatomy, and the second half of the book with the observational aspect of the serious study of birds. The language of birds, the mechanism of flight and migration are there discussed in great detail—including their purport, variation, and the problems of their correct observation and interpretation.

Perhaps the illustrations and lay-out of the book are too reminiscent of that bug-bear of our schooldays, the old-fashioned textbook, but this feature may be excused to the detailed care which characterizes everything Professor Patten writes. The new volume should interest particularly the many readers who have become acquainted with his work in the columns of this journal.

The Social Insects : Their Origin and Evolution. By PROFESSOR W. M. WHEELER. International Library of Psychology, Philosophy and Scientific Method. (Kegan Paul. 21*s.*).

This is a series of twelve lectures delivered in 1925 at the University of Paris while the author was occupying a Harvard exchange professorship. They were first published in French, but the English edition is much enlarged. As in his earlier book, "Social Life among the Insects," the author begins by stating that, besides the struggle for existence, there is amongst animals a tendency to co-operation. But except in title the resemblance between the two volumes is remarkably small, although the same subjects are referred to. The previous volume was entrancing because it detailed the habits of social insects, and the present one is equally so because it discusses the habits and uses with great caution and wisdom. Similarities of habits are cited as evidence of relationship, and the author speaks of "behaviour patterns" running through groups.

After an introductory chapter, in which, incidentally, the inheritance of acquired characters is assumed as part of the biological faith, there are four chapters dealing with the evolution of social life in the hymenoptera, followed by one on that of the termites. Then there are two chapters upon the evolution of polymorphism, mainly discussing the ants, which have specialized in that direction, and the next chapter deals with trophalaxis as a factor in the evolution of social life. In the earlier work this subject was frequently referred to, but the author has now modified and developed the theory which he first put forward in a paper in 1918. Chapters X and XI discuss the evolution of guests and parasites and the evolution of parasites amongst the social insects themselves, both interesting subjects and very well worked out.

As usual in this author's works, there is an excellent bibliography.

FRANK BALFOUR BROWNE.

The Ancient Wells, Springs and Holy Wells of Gloucestershire. By R. C. S. WALTERS, B.Sc., A.M.Inst.C.E. (The St. Stephen's Press, Bristol. 12*s.* 6*d.*).

"The customs, long preserved among the mountains,
Should not be lightly left to pass away.
They have their moral, and we often may
Learn from them how our wise forefathers wrought,
When they upon the public mind would lay
Some weighty principles, some maxim brought
Home to their hearts, the healthful product of deep thought."

With this verse the author appropriately ends his account of past and present ceremonies held annually, or oftener, at the site of ancient wells, especially those in Gloucestershire, for the book is both an account of those still practised and a stimulus to those interested to collect and preserve accounts of others.

The holy wells in Gloucestershire at the present day are nearly all dedicated to a saint, are said to be capable of curing disease or granting a wish, and are only rarely decorated with flowers. Annual festivals are still regularly held at some of these ancient wells, most often in rural areas. Perhaps two of the more widely known "flower-decorating" ceremonies are

those held annually at Stowe, near Lichfield, and Tissington, Derbyshire. They are both described, although held far outside the boundaries of Gloucestershire.

The study of the traditional legends about these wells is an interesting branch of folk-lore; and of the many mentioned, perhaps the most unique is that of St. Kenelm's Well, Winchcomb. Kenulf, King of Mercia, who founded Winchcomb Abbey in 789, was succeeded by his seven-year-old son; but Quenride, his ambitious half-sister, persuaded his tutor to do him to death and hide his body far away in Clent, Worcestershire. A pure white dove, however, bore this message to the Pope: "In Clent in Cowback, Kenelm King's bairn lieth under a thorn, bereft of his head." His body was found and brought back to Winchcomb by Clent monks, and wherever the body rested on the journey, springs miraculously appeared; St. Kenelm's Wells at Winchcomb and Clent being the two which remain flowing to this day. Similar legends may amuse us to-day, but they show the credulity of the pilgrims of old, and are instructive in showing how much of the ancient pagan ritual was incorporated into Christian festivals. Excavations at these sites yield much archaeological material, owing to the Roman practice of throwing coins and other objects down wells in an act of "worship," as described by the author in *Discovery* (November, 1926), when several of the photographs first appeared.

The Bishop of Gloucester contributes a preface to this interesting book, which we join him in commending not only "to those to whom the historical memorials and the picturesque beauties of Gloucestershire are dear," but to all who are interested in the primitive thoughts and ideas of mankind.

A. R. E.

Hanno, or the Future of Exploration. By J. L. MITCHELL. (Kegan Paul. 2*s.* 6*d.*).

This volume is one of an admirable series published under the title "To-day and To-morrow." The publishers tell us that these books "written from various points of view . . . provide the reader with a stimulating survey of the most modern thought in many departments of life." Readers of *Discovery* are, we believe, keenly interested in all such surveys, and are prepared for a certain amount of fantasy provided that the pamphlet is written in reasonable language and has some basis for its imaginative prophecies, but imagination of the gas-bag variety set upon a minimum of ill-digested data will not do, and when there is added a distinct flavour of acerbity the result is a poor thing. It is well enough to dream of a helicopter which is to make all land exploration possible and easy, or to envisage the future traveller penetrating to the bottoms of the ocean basins in super-machines. But such innocent dreaming should not be mixed up with vague insinuations against past explorers and obscure pronouncements upon the faults of modern travellers.

We are forced to wonder upon what authority it is stated that the discipline of past expeditions has been "productive of little more than sloth, indifference and responsibility-evasion," and why it should be described as "monkey-adornments of uniform" and "clownish posturings." Indeed the book is rather stamped by the constant use of such immature journalese as "wonder-urge," "magnetic allure," and "searchlight-stabbed darkness." Nor should it be necessary to dub the conqueror of Mexico a "meanly-bearded clown."

Surely the editors of the series must have been nodding to have passed such a sentence as "Resultant on strange desert stravaigings with undigested caravans, the European presses yearly disgorge stout volumes of unbelievable stodginess and inaccuracy." It is difficult to see any connexion between future exploration in the Antarctic or the moon and the debatable subject of contra-conception, but the author succeeds in introducing the subject. Were it not for this turgid and sententious style it might be amusing though not instructive to follow the author into the interior of the earth which he is confident is a hollow sphere, but reasonable men have patience with absurdities only when they are really well told. The book is altogether trifling, full of puff and immaturity, and entirely unworthy of those of its fellows in the series which the reviewer has read.

Polar Research Institute, Cambridge. F. DEBENHAM.

The Modern Malay. By L. RICHMOND WHEELER. (George Allen & Unwin. 15*s.*).

Mr. Wheeler's book is a welcome addition to the literature of the Malay Peninsula. For although much has been written about various aspects of Malayan life, change in the Peninsula has been rapid since the war. How it affects the Malay may be estimated from the remark that the records of religious beliefs and customs and the folk tales which once loomed so large in native life are now of interest to the ethnologist only, and in no way represent the real thoughts and beliefs of the people. It is admitted, however, that a great deal of such superstitious practice and belief is still to be found among the uneducated Malays. Mr. Wheeler, therefore, does not linger too long over the past. His account of the history and ethnology of the Peninsula is, however, adequate enough to supply the background for his picture of the present day.

It will perhaps come as a surprise to many who are not acquainted with actual conditions to find for how little the Malay appears to count in the active centres of life in the Federated States, due in part to the fact that in the communal and productive life the part which in other communities would be played by the native and the European trader is here taken by Chinese and natives of India. Town life does not appeal to the Malay. Mr. Wheeler by no means shares the pessimism with which these facts have inspired other writers, and sums up his survey of the people as they are to-day in a decidedly optimistic vein as to the possibilities of the future.

E. N. F.

The Lure of Bird Watching. By E. W. HENDY. (Jonathan Cape. 7*s.* 6*d.*).

In his introduction to this volume Mr. J. C. Squire reminds us of some of the memories of earlier years conjured up by the phrase "The Lure of Bird-Watching." Of a youthful egg-collecting expedition, he writes: "The eggs were the prize and the collection the goal: at least I never stripped a nest. There, perhaps, lies the secret: . . . unchecked, the birds would get out of hand; over-plundered they would be extinguished. An awareness of this probably accounts for the fact that half the most ardent bird-lovers in England are also eager shots. They will shoot one kind of bird, which is very common . . . they will no more think of shooting another kind than they would think of shooting their brothers and sisters."

Although there are to-day a host of observers who watch birds with enthusiastic affection and would never dream of killing a rare bird, yet, with all the measure of protection afforded by law to the less common of our native species, there is much

work to be done by bird-lovers in order to educate the public, and particularly the youthful section of it, to appreciate the enjoyment of watching a living bird in its natural surroundings, rather than of keeping a pet in cruel captivity or of gloating over a costly array of eggs of rare species.

Mr. Hendy introduces us to some of the trials as well as the joys of the ardent naturalist. There are not many who would enjoy a day spent in catching and ringing puffins and gulls in their filthy holes; yet such work has its compensation for the enthusiast in the knowledge so gained of bird migrations.

Foreign visitors as long ago as the Middle Ages observed that the English were fond of the country. That fondness still remains in a large percentage of our population, whatever the effect of the overcrowding in great centres. The chapter on the aesthetic appeal of bird watching will thus be read with general interest, as also will be the following detailed description of observations on a few species of especial interest for their rarity or beauty. The observations on "bird song," "birds in captivity," and "birds and bird-tables," will add another to a long list of pleas for a more "humane" interest in ornithology. Altogether this is a delightful book.

Rocks and Minerals. A magazine for collectors. (Edited and published by Peter Zodac, Peekskill, New York. 35 cents.)

A certain section of *Discovery* readers may be interested to learn of a fairly recent addition to those quarterly magazines published for collectors. An American publication, "Rocks and Minerals," is the official journal of the Rocks and Minerals Association. It is not solely of American interest, although at present compiled chiefly on American data. The current number contains particulars of a reward of $5,000 promised for the location of a deposit of dolomitic limestone, known to occur within a certain defined western area, which is sensitive to static electricity. Side by side we find notes for the amateur and descriptive articles on rich mineral areas. An interesting feature of the immediate past and future numbers is a complete alphabetical list of gem names.

The cost is 35*c.* per copy—$1.25 per annum for foreign subscribers; and we understand that the magazine is the only non-technical American publication devoted to minerals.

Preparation of Scientific and Technical Papers. By S. F. TRELEASE and E. S. YULE. (Baillière, Tindall & Cox. 7*s.*).

It is a regretable fact that many scientific research workers and others are unable to write in simple yet scientific phrase for both the general reader and their fellow-workers.

The material contained in this volume was drawn up in the first instance for the use of students writing themes and theses at the college of Agriculture in the University of the Philippines. Enlarged and put into book form, although published at a high price, it will be an admirable guide to any submitting manuscripts for publication—a time saver to author as well as editor, since among the useful data a list of printers' correction marks is included.

Horology. By J. E. HASWELL. (Chapman & Hall, 25*s.*).

The main object of this treatise is to provide information and technical data for the serious student. A short consideration of time measurement precedes the main account of the history and construction of time-recording instruments from the earliest Egyptian and Babylonian "Clepsydia" to the most intricate and refined modern marine box chronometer. The print and illustrations of this volume are excellent.

The Earth and its History. By J. H. BRADLEY, JNR., Ph.D. (Ginn & Co. 12*s.* 6*d.*)

Old Mother Earth. By K. F. MATHER. (Harvard University Press. 11*s.* 6*d.*).

Following the precedent of the majority of University professors, Dr. Bradley tells us that this volume has grown out of the need for an elementary text-book for use in a short course. The material is arranged with an eye to general principles rather than to special applications, and in pursuance of this plan only a very short general account is given of the detailed geological history of the North American Continent, whilst the history of life on the earth and the growth of knowledge of the earth is treated comparatively fully. For a one-year course this text-book is quite a valuable addition to that long list already available.

Fifteen essays, based on broadcast talks from the WEEI Station, Boston, during last winter, are brought together in this second volume with many well-produced illustrations. The subjects are treated in a simple manner for the general reader, and are written in a very readable style. Although the appeal of this book must be primarily to the American public, our chief critism of the series of essays is that reference is made only to American natural phenomena.

Symbols and Formulae in Chemistry. By R. M. CAVEN and J. A. CRANSTON. (Blackie & Son. 15*s.*).

In no sphere of science is it truer than of chemistry that no student can grasp the real meaning of modern scientific theory until he has become familiar with the attempts of past generations of workers to explain phenomena which may yet remain mysteries; and in particular of the study of chemical constitution and reactions where the manner of representation is symbolic—and has been at any one time representative of the stage reached in the progress towards modern chemical theory.

The authors have traced the use of symbols and formulae from the days of old when the alchemists used their picturesque representations of the metals borrowed from Egypt, through the days when Dalton first laid the foundations of modern symbolism, and the nineteenth century with its research and controversy on the constitution of matter, to the present day with its complex theories of valency and stereochemistry. The revolution in thought, brought about by Dalton's views on the atomic structure of matter, and Berzelius' electrochemical theory, may be said to have initiated the growth both of modern chemical theory and symbolic representation.

Oddities: a Book of unexplained facts. By R. T. GOULD. (Philip Allan & Co. 12*s.* 6*d.*).

This collection of eleven unexplained "mysteries" which have remained unsolved, some of them for centuries, provides interesting reading. The Devil's Hoofmarks, seen in Devonshire after a snowstorm in 1855; the vault at Barbados in which the coffins were continuously found disturbed by an unknown agency through the course of years; the possibility that two ships seen stranded on an iceberg near Newfoundland in 1851 were those of Sir John Franklin's last expedition of 1845—these and other "phenomena" are collected together and all the possible *and probable* explanations given. As no completely satisfactory answer can be given to any one of these, the reader is left in that delightfully perplexing state of mind which is always terminated in detective mysteries.

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Editorial Notes.

THE disquieting number of recent accidents on the British railways, following the serious disaster at Sevenoaks in the summer of 1927, has roused interest again in the problem of safety. Considerable publicity has just been given to an automatic brake which employs a light-sensitive device to operate it, but from inspection by the railway authorities this appears to be no improvement upon an electrical system already available. Yet the value of scientific discovery in the prevention of accidents cannot be over-estimated, and it is far from satisfactory that existing safety appliances are still only sparsely employed. As Lord Monkswell points out on another page, however, it is hopeless to look either for the introduction of the highest class of machinery or for its proper utilization, unless sleepless vigilance and energy inspire the proceedings of the men who exercise the supreme control over our railways. An effective connexion between signal and engine brakes, for example, is put down extensively on the London sections of the Great Western Railway; wherever practicable it surely ought to be extended at once throughout the country. Allowing for differences in local conditions, the public should demand the reason for the evident delay in such vital matters.

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The British Science Guild's long-promised report on the reforms needed in the patent system is reviewed in this issue, with particular reference to the scientific worker. The matter has a wider bearing on the unemployment problem. A good patent system tends to encourage inventions of the pioneer type—that is, inventions which break new ground, create new demands, and so absorb surplus labour. On the other hand, a bad patent system may do harm all round by hampering industry. The British Science Guild believes that the proposals in its report will, if adopted, go far to remedy some of the well-known defects, such as the grant of numerous invalid patents, and the exasperating and costly delays which at present harass the inventor. The committee which drew up the report had some difficult problems to solve, but thanks largely to the patience of the chairman, Dr. Eccles, they have succeeded in thrashing out a considerable number of practical proposals.

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Most inventions are so simple that we only wonder why they were not thought of before. From the technical aspect this is the chief comment to be made on the "vitaphone," a talking film apparatus employed last month for the first time at a London theatre. Unlike the "movietone," in which sound and action are produced from a single film, the vitaphone merely consists of a gramophone operated in unison with the cinema projector. A disadvantage of this method is that synchronization is liable to be imperfect, the record being set in motion by human aid, but the performance we witnessed was remarkably exact in this respect. In the movietone the two elements are inseparable, as the sound waves are themselves photographed side by side with the pictures on the film, from which they are made audible by a light-sensitive device. The volume of sound so obtained is weaker than from the gramophone, but this factor is compensated for by the absence of needle "scratching" which is noticeable in the vitaphone.

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The more interesting aspects of these inventions is their probable influence on the technique of film production. There are still conservative critics who refuse to recognize the cinema as an art, and just when it may be said to have established in this respect definite claims, these are likely to be overshadowed. The change from regarding the film as a substitute

for the living actor, to a medium which is capable of special effects, has been given great impetus by such productions as the German film "Metropolis." The limitations of the stage have been discarded for vast effects with an entirely separate technique, and should speech now be generally demanded in cinema entertainment, these new effects are bound to suffer.

* * * * *

The British Association has now issued a preliminary programme and invitation circular for the South African meeting, to be held next year from 22nd July to 7th August in Cape Town, Johannesburg, and Pretoria. The meeting will take place under the auspices of the South African Association for the Advancement of Science, who are at the same time holding their twenty-seventh meeting. After the opening session at Cape Town the members will have an opportunity of breaking their journey to Johannesburg at Kimberley, and there availing themselves of the invitation of the De Beers Consolidated Mines Company to view the operations at their diamond mines. The final proceedings at Pretoria will be followed by a series of interesting excursions. Members will be able to travel over five thousand miles by train during forty days in South Africa, and still be back in England in September in good time for the start of the University term.

* * * * *

Following our reference last month to the Zimbabwe ruins, which the Association will investigate, some preliminary results are reported by the German expedition now working there. According to the *Morning Post*, the theory that the ruins are the remains of a native fortress is derided by Dr. Frobenius, the eminent German archaeologist, who holds that Zimbabwe was the chief mining town of an ancient race, with ramifications over a vast area. Although unable to state yet to what remote period they definitely belong, he says that these ancient people not only had enormous knowledge of geology, but possessed technical mining skill of which even we of to day are ignorant. Shafts have been discovered sunk with perfect accuracy to a depth of fifty feet, with drives underground extending eighty feet and perfectly shaped. When investigating among the natives Dr. Frobenius found many ancient mining tools used as ornaments, which may have been stolen by their ancestors from the dwellers of Zimbabwe. He anticipates spending another year in South Africa.

* * * * *

The Second International Conference and Exhibition on Light and Heat in Medicine, Surgery, and Public Health was held a few weeks ago in the Imperial Institute, University of London. These were organized under the auspices of the *British Journal of Actinotherapy*, and were primarily intended for those professionally or commercially interested. There was, however, much to interest the public both in the exhibits and the progress that they represented. Discussion has lately occurred in the Press on the dangers of the unsupervised practitioner in this department of healing, yet there are now lamps on sale that have been designed to meet the "requests from the medical profession for a mild power ultra-violet ray lamp that could be used in the home without supervision, particularly for ailing or weakly children . . . without possibility of danger." The exhibits showed the increasing use of ultra-violet rays and "radiant heat" for the prevention, detection, and cure of disease. For example, a demonstration was given proving the value of certain rays in detecting ring-worm of the scalp—the diseased hairs showing up by their fluorescence on exposure.

* * * * *

The first attempt to be made in England to provide an adequate electricity supply in a rural area, along the lines of established practice in other countries, will, it is hoped, be the outcome of a scheme prepared by Mr. R. Borlase Matthews for a large area in Lincolnshire. One of the most obvious reasons for the backwardness of our rural electrification is the exceedingly high cost of transmission and distribution lines in this country. This is largely responsible for the fact that, whereas in Germany 90 per cent of all agricultural land is in districts where an electric service is available, here there are only about 2,700 farms connected to power mains. More than the mere existence of an electricity supply is needed to make rural electrification a success. An appreciation of its drudgery-saving qualities is best aroused by an intensive propaganda campaign. When the rural dweller realizes, for instance, that the use of electricity for lighting is cheaper than the employment of oil lamps, and that electric motors can pump water more cheaply than can be done by hand, he will become eager to be connected to a public supply.

* * * * *

An important series of articles on the "next step" in various sciences will begin in January. Contributors already engaged include Sir John Reith (Wireless Broadcasting), Colonel the Master of Sempill (Aviation), Professor J. Arthur Thomson (Biology), Mr. O. G. S. Crawford (Archaeology), Dr. Crommelin (Astronomy), and Mr. Frank Debenham (Exploration).

Railway Accidents and their Cure.

By Lord Monkswell.

The recent crop of accidents on the British railways brings the question again to the fore, How far is such disaster preventable by scientific means? Lord Monkswell examines the present safety arrangements, and combines severe criticism with some constructive proposals of the highest importance to the public.

As soon as the first railways were opened it became apparent that the question of the safety of the new means of transport was one of great importance. The small resistance to traction of vehicles running on iron rails which is the great advantage of a railway was also the thing that rendered the problem of controlling them so difficult. The impetus of a train running at high speed was so great that it was impossible for a driver to see far enough and clearly enough to be sure that no obstruction lay in his path, and, owing to the low degree of friction between wheel and rail, handbrakes on the engine and guard's van took a long time to pull the train up. In these circumstances it became apparent that it was desirable to post at intervals along the line men who would signal instructions to the drivers, and to equip the trains with brakes upon all or most of the wheels. In this way the "block system" of signalling and automatic continuous brakes came into existence. These are the foundation of the measures for securing the safety of railway traffic at the present day.

The Block System.

The general idea of the block system is to divide the line up into sections, at the beginning of each of which is posted a man who will not allow a fresh train to enter that section till he has been notified by the man posted at the beginning of the next section that the last train which passed on to the section between the two has proceeded out of it. The block system is supplemented by the interlocking of points and signals in such a manner that, before a train is permitted to proceed on its way, all points must have been correctly set for the proper road and those of adjoining lines set in such a manner that no vehicle can be turned on to the line which the train is to traverse.

Automatic continuous brakes enable the driver to apply brake-blocks upon all the wheels of the train as hard or as gently as he wishes. In case the train accidentally divides the brake is automatically applied to all wheels with full force.

The above sketch describes very shortly the arrangements in force on most of the chief main-lines in the world for securing the safety of trains which follow one another along these lines. The principle is that the signalman has complete knowledge of the conditions upon the section of line in his charge, and instructs the driver through the medium of the signals.

Obvious Dangers.

Two obvious dangers are not provided for. The signalman may make a mistake and may instruct the driver to do something dangerous; the driver may fail to carry out instructions which the signalman has given him. Both these dangers may be obviated, in theory completely, and in practice very largely, by an extension of the principle of interlocking beyond the point at which it now usually stops short. It may be made physically impossible for the signalman to instruct the driver to run into danger; and by interlocking the signals with the brakes it is possible to stop the train automatically even if the driver fails to obey an adverse signal.

But it must not be forgotten that the signals are only a concession to human frailty and to the imperfection of all earthly arrangements. The mainspring of the working of a railway is the great ordered plan for moving the traffic which is embodied in the time-table. In an ideal existence where the plan in the time-table could always be exactly followed, signals would be unnecessary. On any railway where there is a considerable traffic it would, as it is, be quite impossible to work it at all unless the movement of almost every train were foreseen and exact times laid down showing when each train was due to complete each stage of its progress. The success or failure of the working of a railway depends primarily upon the closeness with which the plan set forth in the time-table is adhered to. And this in turn depends in the first place upon the willingness of the officials who control the railway to accept the responsibilities of their position, to issue full and reasonable instructions to their subordinates actually engaged in carrying on the traffic, and to see that these instructions are properly carried out; and in the second place it depends upon the discipline, training, and intelligence of these subordinates. The

responsibilities of the higher officials obviously include a tireless striving continually to introduce desirable improvements in engines, carriages, wagons and road, so as to render as remote as possible the chances of breakdown and accidents resulting from breakdowns. Perfected machinery can do much to increase the safety of railway working, but it is hopeless to look either for the introduction of the highest class of machinery, or for its proper utilization unless sleepless vigilance and untiring energy inspire the proceedings of the men who exercise the supreme control over our railways.

Let us therefore now turn to the actual history of these undertakings and see where we stand. It must in the first place be pointed out that Great Britain had a long start of all other countries in railway development and that no other country has ever provided its railways with so large and rich a traffic in so small an area. British railways have therefore enjoyed opportunities greater than those of any other country, and should consequently have produced results superior to those produced in all other countries.

The first quarter of a century may be regarded as perfectly satisfactory. Between 1825 and 1850 British railways prospered amazingly and rapid progress was made in most directions. But though many of the original imperfections in railway appliances were eliminated during this period, many more remained, and nothing approaching adequate methods for securing safety had so far been evolved. From about 1850 onwards pioneer energy and enthusiasm rapidly declined, the administration of the railways passed into the hands of a body of officials who seem quite deliberately to have done everything in their power to restrict further progress to little routine improvements and as few as possible of them. I note that even Sir Felix Pole in a recent article in the *Nineteenth Century* is constrained to admit that in the 'seventies and 'eighties British railways failed to make any progress worth speaking of. I am afraid that this dead period started sooner than Sir Felix allows and lasted much longer. Indeed there has never been more than temporary and partial recovery.

The Bill of 1889.

In these circumstances, adequate arrangements for securing the safety of railway traffic encountered, in common with most other desirable improvements, such strenuous passive resistance from the railway officials that their introduction was very seriously delayed, and such progress as was made was mostly due to outside pressure, particularly from the Board of Trade. Eventually in 1889 a bill became law which enabled the Board of Trade to order the railways to adopt the most necessary safety appliances and resistance to the use of these things was finally broken. It could not be expected that safety appliances adopted in such circumstances would be either so well suited for their purpose, or so satisfactorily worked, as might have been the case if the railway companies had adopted them willingly and had spontaneously made every effort to make them as perfect as possible. Serious accidents have taken place since the adoption of block signals and continuous brakes owing to mistakes on the part of signalmen and drivers, many of which could have been prevented by mechanical means. Drivers have inadvertently passed signals at danger, signalmen have allowed trains to proceed on to sections of line already occupied. There is no insuperable difficulty in the way of designing automatic machinery to obviate at least the great majority of accidents of this type. Something has already been done in this direction, but always slowly and unwillingly and therefore much less efficiently than should have been the case.

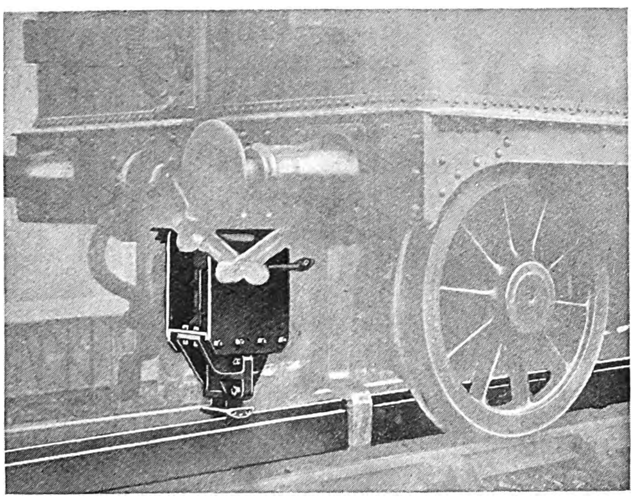
Punctuality Vital.

And, beyond the question of the introduction of actual mechanical contrivances to ensure safety, there are further matters already alluded to which concern the spirit in which the officials and men do their work. To reduce the number of opportunities for accidents punctuality is a matter of the first importance. What have the officials done to ensure the utmost possible measure of punctuality? In the imperfect world in which we live delays will occur from time to time. When a train is late the only possible way of minimizing the dislocation which it causes is to make up as much of the time lost as possible. This question of making up lost time is obviously one of the highest importance as affecting the safe working of the line. If certain trains from Euston, which were running late one night in May, 1915, had made up time so as to reach Carlisle punctually the dislocation which alone made the Quintinshill accident possible could not have occurred. Two hundred and twenty-four persons perished in that accident. Twelve persons lost their lives in a collision at Hull in 1927 which could not have occurred unless one of the trains had been late and so out of its proper place in the great scheme for working the traffic.

In the face of all this the Great Western is the only big railway in this country that even notices the question of the making up of lost time in the instructions which it issues to its drivers. The Chairman

of the London and North Eastern has gone so far as to state in public that the management of that railway refuse to issue any definite printed instructions on the subject. The officials seem to have the crazy idea that by steadfastly burying their heads in the sand they can shift on to the shoulders of their humbler subordinates a cardinal responsibility that is obviously their own. In these circumstances the whole question is naturally in a state of chaos. A few of the best drivers sometimes make up time, and it is commonly remarked that it is just the men who make up time that also most carefully respect the speed limits at dangerous points. The great majority of drivers never make the least attempt to regain lost time even when it is easy to do so.

In the same way the railway officials avoid testing the road and rolling stock by means of high speeds. Road-motor manufacturers have found out that to ascertain the weak spots in a car there is nothing like the test of long continued high speed. The same is obviously true of railway material of all kinds. But railway officialdom dislikes energy in all its forms and carefully avoids high speeds, with the result that the weak spots in railway material are not disclosed and second rate designs will do well enough.



AUTOMATIC TRAIN CONTROL.
This device is used in the London district by the G.W.R., and consists of an engine shoe (below the buffers) which engages a ramp (between the rails) connected with the signal.

All British railways open to public traffic are now protected by the arrangements set forth in the Act of 1889, and a certain amount of further progress has been made. One of the things, for instance, that has led to accidents in recent years has been that there was nothing to prevent a signalman from forgetting the presence of some vehicle which had been left standing on the section of line under his charge, and admitting a train on to this section. In many places arrangements have now been made for passing an electric current through the rails the short circuiting of which, through the wheels and axles of any vehicle standing on them, automatically prevents the signal from being lowered for a fresh train. Various methods also have been introduced on a small scale for automatically stopping the train if a driver passes a signal at danger. The most extensive arrangement of this kind is that which the Great Western Railway has put down in the London district. A ramp, some thirty feet long, is placed between the rails and comes in contact with a steel shoe carried by the engine. If the signal is at "danger" the contact of ramp and shoe applies the brake, at the same time blowing an alarm whistle in the cab of the engine. If, however, the signal is at "line clear" an electric current is passed through the ramp, which, when contact between shoe and ramp takes place, neutralizes the action already described and merely rings a bell as a positive indication that all is well.

All this is quite satisfactory as far as it goes. Such safety measures as have been put into operation would appear to be on the right lines. But they are much too slow and halting. As I have already remarked, even since the introduction of the block system, numerous accidents due to perfectly well ascertained causes have taken place many of which might have been avoided if proper arrangements for their prevention had been in force. I am not so hopeful as to suppose that it will ever be possible entirely to eliminate accidents, but that their number can be drastically reduced I regard as certain. The way to reduce them is to put much more energy into the perfecting of mechanical safeguards; to give much more encouragement to inventors; to adopt much more readily apparatus that shows itself to be satisfactory; to issue proper instructions to the staff and see that they are carried out.

This will never be done till a new spirit enters into the railway managements. The habit of despising the public and the shareholders, of resenting advice and meeting with boycott any and every attempt to secure reasonable reform is so ingrained in the official clique in general that even high officials who themselves realize the situation and wish to change it—I am glad to believe that there are some—lie helpless on the bed of Procrustes. The cure will be when an explosion of public feeling forces officialdom to mend its ways.

Excavations at Constantinople, 1928.

By S. Casson, M.A.

The following is the first published account of the excavations made in Constantinople during the past summer. Continuation of the earlier work (described in our March number) has revealed a triumphal arch of a type hitherto unknown, forming a discovery of the highest importance in the history of architecture.

THE second season of the excavations at Constantinople commenced with the clearing of an area of great importance at the north-east end of the Hippodrome, immediately in front of St. Sophia. Here last year were found the great foundations of what were thought to be the famous Baths of Zeuxippos. Four massive pillars built of alternate brick and stone courses were uncovered to a depth of nearly twenty feet and, in the process, a fine slab of a sculptured frieze was found. Still, it was uncertain, at the end of the excavations last year, what this building was and how far it extended; nor was its orientation established nor much known about its date. The end of the Hippodrome was found apparently abutting on it, but the relation of the two buildings was not at all clear.

NEW TYPE OF STATUE-BASE.
Carved with the name *Hecuba* in early Byzantine letters, this was one of three statue-bases of a new type discovered in the Baths of Zeuxippos. It is here seen upside down, for in actual use the name appeared at the top.

Our greatest efforts, then, were this year concentrated upon establishing the nature and history of this building, the Baths of Zeuxippos—if such it was—being famous in antiquity as the one building in Constantinople where the bulk of the old classical world of Greece and Rome survived in the form of sculptures and bronzes; it was, in fact, to the Byzantines an old-fashioned place where the old world of pagan times could be studied. A Byzantine poet, Christodoros of Thebes in Egypt, preserves for us, in the form of a series of exercises in Greek poetry, descriptions of the numerous statues that decorated the building. His language is archaistic and elaborate, and his masterpieces read like the poems of a Babu, which he probably was. But they are useful for us as giving us some account of a building, itself Roman rather than Byzantine, in which were preserved large numbers of the works of art of a non-Christian world.

The excavations started where they had been concluded last year. The building which had then been an enigma now began to unfold itself and its plan began to be more evident. A great and complicated public building emerged from the soil, often going down to over twenty feet in depth and involving great effort in the clearance. The excavations had not been long in progress when two large altar-shaped marble drums were found at the foot of a wall. Both were alike in type and, on examination, both were recognized as statue-bases. On one was the name "Hecuba" in letters of the early Byzantine period. The exact type of statue-base was a new one, entirely unlike the low flat rectangular bases of the Hellenic period or the more elaborate bases of Roman times. The top of the Hecuba base was cut away so as to allow of the insertion with a powerful dowel of a statue, not in the manner in which Greek statues were fixed to their bases in Greek times, but by a method which presupposed a very solid bronze basis to which the statue (presumably in bronze) was already fixed, or which had been moulded in one piece with the statue.

There had thus been found two bases, each of the same type, which had at some time or other held statues that adorned this building. Not long afterwards a third base, also of the same type, but taller and rather more elegant, and equally well preserved, was discovered. It was inscribed with the name of "Aeschines" (spelt *Aischenes*) in letters of the same Byzantine type.

Here at last we were in touch with something which might identify the building definitely. Reference to the poet Christodoros the Egyptian gave the clue. He describes, in his long and fulsome account of the Baths of Zeuxippos (or the *Gymnasium* of Zeuxippos, as he prefers to call it), two statues which stood together, those of Aeschines and Aristotle—" Aeschines, son of Kekrops, the bloom of wise Persuasion," and goes on to say how " near him was Aristotle, leader of wisdom," the latter (and perhaps the former, though he is not explicit) in bronze. Later he gives us another pair—Ulysses and Hecuba. Of Hecuba he says, " Not even the bronze has brought an end to thy grief . . . but still thou weepest, standing before me. Thy garment, with veil drawn across the eyes, exhibits thy woe, and the peplos, falling loose to thy feet, does not disguise the sorrow beneath it."

What are we to infer from these descriptions and what can we now decide as to the nature of the buildings in which they were found? There can be no doubt; here are the Baths of Zeuxippos and here are the bases of some of the statues which decorated it. The fact that Christodoros calls the bases, upon which the statues he describes stood, *bōmoi*, or altars, is descriptive enough, for these three bases are all in the form of Roman altars. The literary and archaeological evidence thus agrees even on points of detail.

Two main buildings were excavated, standing side by side. One was a complex of rooms, the other consisted of a large apse-shaped chamber paved with marble and opening on to a marble paved courtyard surrounded by columns. The latter may well have served as the Propylon to the former, and since the former had in one place a dome-covered pillar-supported chamber of great size, there can be little doubt that it served as part at least of the Baths. The fact that the relief found last year depicted a sea scene with nereids and perhaps similar sea-deities shows that the decoration of the building was in keeping with its purpose. A second fragment of this same frieze was found this year. A long-sought-for and famous building of old Byzantium has thus been now added to the scanty list already known, and the topographical history of the city is the richer. And further, the literary exercises of an obscure Egyptian have been shown to contain a value for further research which, without archaeological verification, their language could not in the ordinary way have been expected to hold.

THE BATHS OF ZEUXIPPOS.
Building discovered near the Hippodrome, now definitely identified as the Baths of Zeuxippos. On the right is seen the outside of a large apse.

AFTER THE EARTHQUAKE.
Architectural fragments, as strewn by the earthquake of A.D. 732, now unearthed. Part of a column in the centre shows the unique " palm-tree " decoration.

Of the minor finds in this area there were many of great value. Most important from the artistic point of view was a small jewel of pure gold decorated with the head of a saint in enamelled *cloisonné*. The name of the saint was also inscribed in *cloisonné*, and proved to be Saint Procopius, a saint much venerated by the Byzantines of Stamboul. Jewels of this type usually belong to the tenth or eleventh centuries, though the goldsmiths still produced *cloisonné* down to the thirteenth century. But the finest are of the tenth century. This jewel seems to be of the best and earliest style. The colours of the enamel are still fresh, the background being in pale blue and the garments of the saint in crimson. The inscription, the halo and details of the dress stood out in the gold cloisons. So few examples of this amazing goldcraft are known and so rare is it that the museums of Europe can hardly enumerate more than a score of pieces. But fine examples occur in the treasuries of European churches and cathedrals whither they

then brought as loot from the Latin capture of Constantinople in 1204. The Treasury of St. Mark at Venice is the richest depository of this goldwork, and much of it is also used in the famous Pala d'Oro behind the altar of St. Mark.

Of the other finds the more interesting were some Byzantine sculptures of the fifth or sixth centuries and a series of most important Byzantine faience vessels, covering the whole period from the fifth to the fourteenth centuries and filling many gaps that remained from the ceramic discoveries of last year.

The Arch of Arcadius.

A secondary but no less interesting area was examined about a half a mile to the north of the Hippodrome near Bayazid Square. Here, inside the courtyard of an old sixteenth century Caravanserai called Sirmakesh Han, the falling of a tree had disclosed massive marble foundations. At the request of the Museum, the expedition undertook the examination of this region. The area of excavation was not large and made extremely difficult by the presence of the walls and chambers of the Caravanserai, itself abandoned and empty. But within a few days it was evident that the ancient remains were very near the surface. While at the Hippodrome we had to go down to a depth of twenty feet and the accumulations of earth due to repeated rebuilding were very great, here the Caravanserai, which had been built in the early sixteenth century and remained unaltered, had prevented any great increase of level. Within a few feet the workmen began to uncover a series of mighty fragments of columns, architraves, capitals and podia which all seemed to belong to one great building. The chaos in which the fragments were at first found seemed to indicate some great catastrophe which had overwhelmed the building. As the fragments were gradually extracted and removed it became clear that we had to do with a great arch of triumph in which many great monolithic columns had supported the main arch. But the identity of the monument was obscure. There was no record in this region of anything except the Forum of Theodosius and his great column, of the type of the column of Trajan at Rome. But there was no evidence beyond tradition for the character and extent of the Forum; the column, on the other hand, had been recently identified almost opposite the Caravanserai a hundred yards, or less, away. A passage, however, in an early Byzantine description of Constantinople mentions what seems to be a great arch of the time of Arcadius actually in the Forum, and describes how statues of Arcadius and Honorius stood upon it; it adds that it was supported by columns in groups of four.

The identity of the arch with these mighty marble fragments seems almost certain. It is not yet possible to essay an architectural restoration of what we have found, but from what we have it seems that there were four or more podia, of which we had cleared two, and that on each podium were four great monolithic columns each some twenty-five feet high. The capitals on the columns were five feet in diameter, and the columns themselves were unique in that they bore on their surface, not the fluting of Doric columns or of Corinthian, but a design which seems to be derived from peacock feathers. No columns of the type are known elsewhere. The capitals, on the other hand, are pure Corinthian. Of the architrave or entablature much was found. On the under face were panels in which fish and pomegranates, leaves and fruit were carved. All seem to have been symbolic and some, like the fish, definitely Christian. We have to deal, then, with one of the largest and certainly one of the earliest Christian public monuments in Constantinople, or indeed in the Christian East. The arch seems to have stood astride the *Mesé*, the central thoroughfare of the city, and perhaps to have allowed passage, like the Arc de Triomphe at Paris, for cross roads. It must have been one of the most central and most striking monuments of the city. But what is remarkable is that it had escaped all mention in the records of travellers.

As far as its history can be reconstructed it is as follows. At some period in early Byzantine history it was seriously damaged by earthquake, perhaps in an earthquake of A.D. 732. Some attempt at strengthening and rebuilding was made, and then in mediaeval times it seems to have fallen finally and for good by a second earthquake. This evidently happened before the Turkish conquest. After the conquest an alchemist seems to have settled among the ruins which, perhaps, were still standing in part. In the sixteenth century, first a public mint and then this Caravanserai were built and the marble columns and surviving fragments were largely removed or levelled. The large remains we discovered had been merely covered with earth when the site was levelled for building, so that the fragments as we found them were in the disorder in which they had fallen when the earthquake brought the columns crashing to the ground. Some few fragments were used in the foundations of the Caravanserai, and most of these can still be seen protruding. It is hoped that in the near future the Turkish Government will expropriate parts of this derelict, if attractive, building, so as to free a larger

area for excavation and make it possible to recover a great deal more of the monument. Even as things are we have unearthed the bulk of three or four columns, two podia and parts of another two columns at least. From a strictly scientific point of view a restoration *on paper* of the arch is certainly possible. But it may be hoped that in the near future something approaching to a restoration *in fact* will be effected. No arch supported in this way on groups of columns is so far known, and this new addition to the ancient monuments of the city is one of the highest value and historical importance. The style of the columns is not the least remarkable of its features: there is no parallel for this peculiar surface decoration. It may be a peacock-pattern or it may be a formalization of the trunk of a palm tree. In either case it is unique, except perhaps for one isolated column of the type in the great underground cistern of Yeri-Batan Serai; but this column itself may have been taken from our arch at a later date to replace one of the columns of the cistern that had been broken or become unsafe.

The funds for the whole of these excavations in Constantinople this year were most generously provided by Sir Joseph Duveen.

Reform of the British Patent System.

THE report on the reform of the patent system just issued by the British Science Guild* presents some features of special concern to those engaged in scientific and industrial research. The report embodies the work of a Committee, appointed by the Guild in 1927, under the chairmanship of Dr. W. H. Eccles, F.R.S., Past President of the Institution of Electrical Engineers, and President of the Physical Society.

One of the recommendations deals with a long-standing grievance of scientific and technical men who present papers embodying the results of their researches to learned societies and professional institutions. Ideas may be published in this way, and afterwards, when it is too late to obtain a valid patent, may be found to have important industrial applications. Such disclosures may be made in ignorance of patent law or through failure to realize the commercial importance of what has been invented. The Committee recommend, as a remedy for the evils of this kind of premature publication, that publications made by or derived from an inventor himself shall not stand in the way of the grant to him of a valid patent, provided that he applies within twelve months after such publication. This provision, if adopted, will provide a breathing space to the investigator between the time when his mind is engrossed with his problem and the expiry of the twelve months, during which he may turn his attention to the possible industrial utilization of his discoveries.

Some valuable observations and memoranda on the relation of scientific research to invention are also contained in the report. It is a well-established rule of law that a patent cannot be valid unless the invention covered by it contains "subject-matter." Now an invention may be thought of in a flash of intuition by a man of genius in the exercise of ingenuity, or it may be arrived at as a result of systematic research by a scientific staff, working along lines which would naturally suggest themselves to scientific men having an adequate knowledge of their subject. It is difficult, however, to draw a clear distinction between such a process of research on the one hand and the use by a skilled workman of the known rules of his art on the other, which does not amount to invention.

The Committee think that the changing conditions of the time call for a clear recognition on the part of the Courts of the new importance which has been assumed by industrial research, and express the opinion that, in deciding upon the presence of subject-matter in any particular instance, they ought to give very favourable consideration to an alleged invention which has arisen from prolonged and meritorious research in the laboratory.

The report also makes a suggestion affecting research workers in the biological and natural sciences, to whom hitherto the patent system has held out little or no inducement to give attention to the industrial utilization of their discoveries. Such discoveries may have a vital relation to the advancement of agriculture. The Committee says that they see no reason in principle why patents should not be granted for such innovations as new varieties of plants (*e.g.*, rust-proof wheats), new applications of parasites for destroying weeds, and other industrial applications of biological science. There would, of course, be considerable difficulty in enforcing the patents in certain cases, but it might well be left to the patentees to find means of doing so. Experiments would probably show that some biological patents could be enforced, but not others, and the matter might fairly be left to the test of practical trial.

* *Report on the Reform of the British Patent System*, November, 1928. (British Science Guild. 2s.)

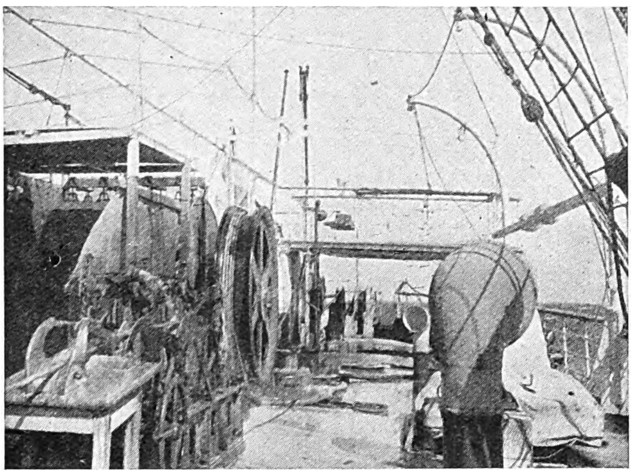
An Ocean Cable of Revolutionary Design.

By William H. Jenkins.

Within recent weeks a new Atlantic cable has been laid which will have the largest message capacity of any in existence. The cable was made in England for the Western Union Telegraph Company, by whose courtesy our contributor was aboard the cable-laying ship during this important voyage.

On the day that Marconi's first wireless signal flashed its way westward across the Atlantic Ocean to St. John's, Newfoundland, there was generated a collateral wave throughout the world of commerce—a wave of speculation as to the probable effect of this new discovery upon established methods of communication. That speculation has recurred with each successive wireless development, and recently on the heels of "beam" transmission.

The full answer to the question leads into a multitude of channels and by-ways, involving the whole fabric of world-wide communication. As in most efforts at diagnosis, however, obvious symptoms may be considered dependable. First on the list of cable symptoms is the fact that traffic over the cables is increasing tremendously. One American company recently reported an increase of approximately 300 per cent in volume since the beginning of the war, the same striking increase continuing up to the present moment. Another symptom, even more convincing than figures, is the action of the Western Union Telegraph Company in developing and laying a new trans-Atlantic cable which will have the largest message capacity of any in existence. By reason of revolutionary principles in cable design, this new communication link is expected to be duplexed, that is, it will be operated in the two directions simultaneously, at a speed rate that will make possible the transmission of four messages in each direction simultaneously—eight simultaneous messages in all, over the single copper conductor!



ON BOARD THE *DOMINIA*.
The cable is seen passing round the brake drum, and thence over the stern pulley wheels into the ocean. The *Dominia* is the world's largest cable ship, having a capacity of 4,000 nautical miles of cable.

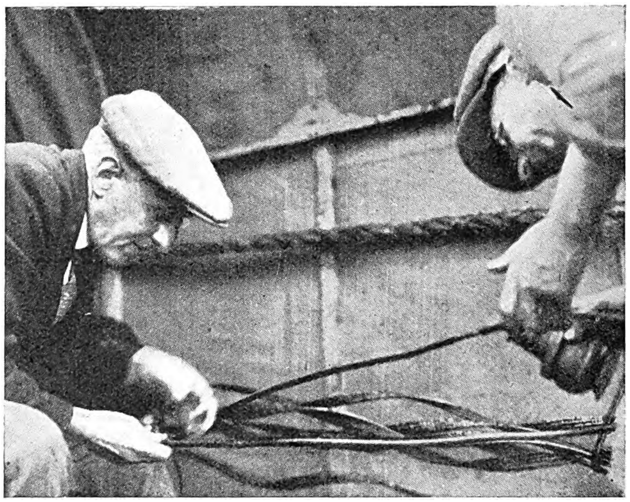
This new cable, which cost more than £350,000 to manufacture and lay, exclusive of the cost of elaborate operating equipment, was made necessary by the increase in cable business. For some time the cable facilities between the Azores and Germany, Spain, Italy, and North Africa have been greater than those between the Azores and America. The new cable, extending from Bay Roberts, Newfoundland, to Horta, Fayal, Azores, will correct this condition, at the same time providing substantial insurance against interruptions of service in the event of failure of the original high-speed New York-Azores cable.

Although the following account of the development leading up to the latest type of high-speed cable sounds relatively simple, it was only by the solution of many highly technical problems that the desired result was eventually obtained.

When an electrical impulse travels through a submarine cable, it is attenuated, or is reduced in magnitude due to the effect of the electrical resistance and capacity of the cable. Not only does it suffer attenuation but distortion as well. In the earliest cables the signals sometimes came through so badly distorted that the instinct of the operator, and even imagination, had to be resorted to at times. The higher the speed of signalling on a given cable, the more marked these effects become. While the distortion of signals can be largely corrected at the terminals by modern operating equipment, the signals must be received with sufficient amplitude to override the extraneous disturbances which are present on all cables in greater or less degree. Increasing the size of the core was one method employed to decrease the attenuation, thus allowing increased signalling speed, and it was successful up

to a point. If a substantial reduction of attenuation were to be obtained at reasonable cost, however, cable engineers decided that some other method must be employed.

The first really new idea in cable design was introduced in 1924. It had long been recognized that "loading" a cable, that is, increasing its inductance substantially, would counteract the effect of its capacity, thus materially reducing the attenuation of the signal. While a cable loaded with iron wire had actually been laid in the English Channel, no magnetic material was known with characteristics suitable for loading long ocean cables. The discovery of a new alloy of nickel and iron, possessing high magnetic permeability, started the remarkable development of ocean cable telegraphy of which the latest cable is a part. The first loaded cable, with this new alloy ("permalloy") in the form of a tape wrapped round the copper conductor, was laid between New York and Azores in 1924, and a signalling speed of 1,500 letters per minute was attained.



MAKING A CABLE JOINT.

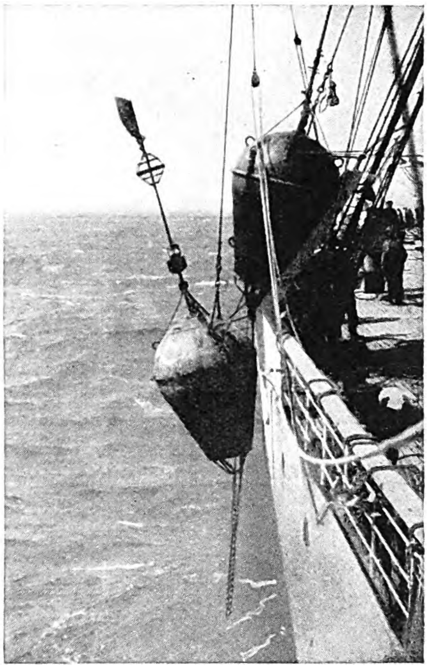
Splicing is a highly specialized task. Many workmen cannot apply the gutta-percha insulation successfully because certain chemical conditions of the skin cause air bubbles which would admit water and cause cable "fault."

Such a speed had never been dreamed of by the pioneers of the cables. Even experienced engineers were sceptical that it could be accomplished. But there were others who were not satisfied even with such a revolutionary achievement. Engineers in the Western Union laboratories believed that four messages could be sent in each direction simultaneously over one wire, stretching across the Atlantic. They worked it out on paper. Then they built an "artificial" cable, composed of the elements of resistance, inductance and capacity which would be encountered in a cable of the desired length and electrical characteristics, and found that it worked. Laying of the cable based on the new principle has just been completed.

The old unloaded type of cable is generally operated duplex, that is, it is operated simultaneously in the two directions, thus increasing the message capacity of the cable. However, due to complications introduced by the loading, it was at first found to be impracticable to duplex the loaded cable for high-speed operation.

In the latest cable there has been combined with the high signalling speed of the loaded cable, the facility of duplexing of the unloaded cable. This has been accomplished in the case of the Newfoundland-Azores cable through the development of the principle of "tapered loading." Thus the middle section of the cable is heavily loaded with "mumetal," of somewhat similar characteristics to "permalloy," the loading being gradually diminished toward the ends, and the final length at either terminal consisting of ordinary unloaded cable. At each cable terminus an "artificial line" was then provided for—a combination of inductance, resistance and capacity which would exactly balance the cable in such a way that traffic could move in both directions simultaneously. The sending instruments were to be connected with both the cable and the artificial line, while the receiving instruments were to be connected across the two lines. Because the impulse from the sending instruments would move outward with equal intensity over both the cable and the artificial line, the receiving instruments in America would not respond to outgoing signals from America. These receiving instruments would respond to the incoming signals from the Azores, however, and the American sending instruments would not be affected by the received signal. The same thing would happen at the Azores end, and both sending and receiving instruments, four of each at each end, would operate continuously, although connected by only a single copper wire across the Atlantic.

It seems entirely unreasonable that four messages could travel in even *one* direction over a single wire at one time. As a matter of fact, it is! What actually happens is that the time on the wire is divided equally between four different sending machines. Obviously, a "speed" of 1,000 letters per minute is beyond the capacity of any one telegraph operator to put on the wire. Therefore, the



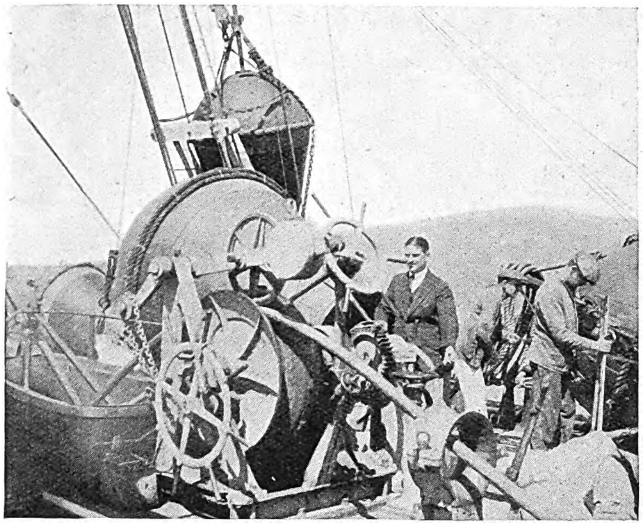
HOW THE DEEP-SEA CABLE WAS LANDED IN ROBERTS BAY, NEWFOUNDLAND.

Left.—The heavily-armoured shore end of the cable is floated to the beach by means of casks, strung like beads at intervals of fifty feet. *Centre.*—Dropping the cable overboard after the shore end had been spliced to cable in the *Dominia's* tanks. · *Right.*—Lowering the buoy to which the deep sea portion is moored. This type of cable buoy is recognized internationally.

wire time is divided between four transmitters operating in continuous rotation. By way of example, suppose we have four messages, the first word of each, in respective order, being as follows: message No. 1, "cat"; No. 2, "rat"; No. 3, "boy"; No. 4, "dog." The first letter to go on the cable will be "c," which starts the first message. Then the transmission jumps to "r," the first letter of the second message, then to "b" in the third message, and finally to "d" in the fourth; after which the second letter of the first message is put on the wire, then the second letter of the second message, and so on through the four messages. At destination a "channel distributor," which is timed exactly with the sending end of the cable, separates out the various "channels" or messages, and diverts each to a receiving instrument. In duplex operation, as on the new Western Union cable to the Azores, this operation is practically multiplied by two because four sending and four receiving instruments are operating continuously at each end of the line, instead of operation being in only one direction at a time.

The laying of the world's fastest duplexed cable was in itself an engineering task of no small proportions. The specifications of the engineers decreed that it must be a cable of 1,341.17 nautical miles, or as near thereto as possible, as any appreciable deviation from this length would not coincide with the very exact calculations that had been made for its operation. The problem was put up to the Telegraph Construction and Maintenance Company, the British firm that manufactured the first Atlantic cable and has made most of the submarine cable laid since that time. This company accepted the challenge, although such close limitations had never been imposed before. It happens that the distance on the surface of the ocean between Bay Roberts, Newfoundland, and Horta, Fayal, over the selected route is 1,264 nautical miles, while the amount of cable specified to conform to the contours of the sea bottom, allowing for the required cable slack, was 1,341.17 miles, as we have said.

While laying of the cable was in progress, engineers aboard the cable ship *Dominia* checked every mile of cable that went overboard, compared this mileage with the actual distance traversed by the ship and with the frequent soundings which revealed changes in the contour of the bed of the ocean. For one period of more than twenty-four hours no sun or stars were visible for the taking of observations. For three days the ship was harried by a cyclonic storm which at times threatened to snap the cable, the deep-sea portion of which is less than an inch in diameter. But the predetermined course was held, and the



MORE CABLE MACHINERY.

Another part of the special equipment of the *Dominia*, showing the cables emerging above deck from the storage tanks below.

amount of cable required by the contract was laid in the ocean. The entire undertaking was completed in a little more than eight days—this being faster time than on any previous cable contract of similar proportions.

A trans-oceanic telegraph cable has but one conductor, which is insulated with gutta-percha, for which no satisfactory substitute has been found since it was first used in the earliest cables. A layer of jute round the gutta-percha acts as a cushion between the gutta-percha and the galvanized steel armour wires which protect the core from damage when laid in the ocean, and outside the steel armour wires is another jute layer to protect the armour as much as possible from corrosion after laying. At the greatest depths, where the cable is relatively safe from marine animals, ships' anchors and other enemies, it is quite small—slightly less than an inch in diameter, as already stated. At the shore ends, however, where there is great danger of damage, it is more than two inches in diameter and quite heavily armoured. Also, in shallow water the gutta-percha is covered with a brass tape, as a guard against invasion by the teredo, a marine borer which has a keen appetite for gutta-percha. Between these two sizes are five gradations of diameter, appropriate for varying depths and conditions.

To make one of these cables, load it into a ship, and then lay it along the bed of the ocean—without damaging the insulation, the fine " mumetal " loading or the conductor—is no insignificant undertaking. The new fast cable was made at Greenwich and loaded direct into the tanks of the *Dominia*, the largest cable ship in the world. It was coiled in the four great tanks in sections, in the order in which they were to be taken out, and the tanks filled with water to prevent deterioration of the gutta-percha. These four tanks have a capacity of about 4,000 nautical miles of cable, which is sufficient for the longest cable that is likely to be constructed in a single section.

Before a cable is laid over a new route a series of soundings are taken and the exact depths charted. This serves a two-fold purpose. It makes possible the avoiding of the greatest depths, where recovery of the cable for repair purposes would be difficult, and it also dictates the amount of cable to be paid out by the ship. Between Bay Roberts and Horta the greatest depth encountered was about 2,800 fathoms (about three miles) which is not prohibitive.

While the *Dominia* is equipped with several types of wire sounding devices, most of the survey work is done with an echo sounding gear, a device which can be employed without stopping the ship. A power hammer in the ship's hold strikes a diaphragm on the bottom plates of the vessel. This generates a distinct note, which travels to the sea bottom and returns as an echo. This echo is caught by a sensitive microphone, also on the ship's bottom. It is then conducted electrically to the depth finder on the navigating bridge, when the elapsed time between the generation of the sound impulse and its return as an echo is translated into fathoms of depth. While laying is in progress, a careful record of depths are noted on the chart, to simplify any subsequent repair work.

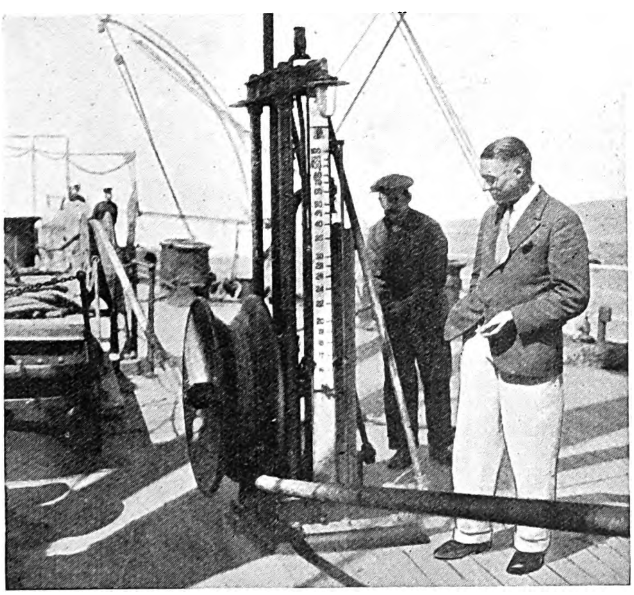
Speed Regulation.

Cable men always speak of " paying out " cable, but in actual practice the cable runs out without any encouragement whatever. The task of the cable engineers is to regulate the speed with which it runs out, so that enough may be laid to cover the route, but that none may be wasted. From the tanks the cable passes three times around the braking drum, and thence through a dynamometer which registers the strain at all times, and finally passes over the stern sheave into the ocean. In a depth of three miles the cable describes a great arc behind the vessel, finally touching bottom twenty miles or more back. In the drum room of the ship, where the brakes are adjusted to regulate cable strain and the amount paid out, are accurate instruments for measuring the amount of cable paid out, the speed of the ship, the revolutions of the engines and the percentage of cable slack being allowed. All of these factors must be taken into consideration in regulating the speed with

which the cable runs over the stern. Continuous electrical tests are also made, to insure continuity of the cable, and once each day the ship exchanges messages with the shore on the progress of the work. These messages must pass through the entire length of cable in the ship's tanks.

In the past, no messages of any length, much less any newspaper stories, were sent over the entire length of a cable while only partially laid. This occasion marked the first time a story was allowed to wind its way around the coils of cable in the tanks of the ship. This story was a report of the progress of the voyage, with a statement by the engineers that the ship was adhering with almost clock-like precision to its schedule.

Conspicuous in the rigging of the *Dominia* as she began her voyage was the internationally recognized sign of a ship engaged in laying cable. A cable ship is not under control, in the usual sense of control at sea. Not only is she physically connected with land by a bond which must never be severed except under conditions of gravest danger, but she must also hold inflexibly to an exact course. The two red canvas globes with the white canvas diamond between them, hung vertically in the rigging, warn all other shipping to give the cable vessel a wide berth. This means that her course shall not be interfered with, and also that for miles behind there is a cable which must not be fouled or overrun. A ship crossing it close to the *Dominia* would have spelt disaster to her work.



THE "DYNAMOMETER."

This instrument registers cable strain and serves as an index to the amount of braking force to be applied. In the deepest sea the cable strikes bottom some twenty miles behind the ship.

BRINGING THE CABLE ASHORE.

Scene taken at Bay Roberts as the ocean cable was carried up the beach, after being floated ashore by the casks illustrated on a previous page.

One of the most interesting pieces of cable ship equipment is the "wire gear," which pays out a taut wire throughout the laying operation. While the log-line is used, it is not an accurate measure of either ship's speed or distance travelled. On the other hand, the fine steel piano-wire, attached to an anchor near shore when the cable laying begins, and kept taut throughout the voyage, serves as an exact tape line, and makes it possible to regulate the paying out of cable, so that the desired amount may be laid with accuracy and with the correct percentage of slack. This wire is wound on drums, 140 miles to the drum, and a new reel is spliced on to the old one before each 140-mile length is completed, so that the tape measure may be continuous. When Horta was reached on the *Dominia's* latest voyage, approximately 1,260 miles of wire were left in the ocean after having served its purpose as an exact gauge of speed and distance.

High adventure, dangerous moments, amazing technical skill, accurate navigation and humdrum routine at times are all to be found on the cable ship. To the cable man his job is a combination of profession and avocation. He may swear roundly at the storm which puts the cable in jeopardy, but the grimness of his battle with the elements has about it much of the same lure that led the discoverers of new worlds into uncharted seas. Romance has not gone out of business, for among the men who go down to the sea in ships, none have more opportunity than the cable man for excitement and thrills, and the ultimate satisfaction of a difficult task triumphantly accomplished.

Ennerdale Water: A Problem for Geologists.

By Robert Gurney, M.A., D.Sc., F.Z.S.

In Great Britain, Ennerdale Water is the only natural home of a certain small creature whose distribution presents an interesting problem. In other countries it occurs only in lakes which are supposed to have communicated directly with the sea. From this zoological evidence the possibility of Ennerdale Water being such a lake is discussed; but the author leaves the question open for geologists to decide.

ENNERDALE WATER lies in one of the western valleys of the Lake District, with Crummock to the north and Wastwater to the south of it. As Dr. Mill says of it in his survey (1895), it is a " narrow deep alpine lake, widening and growing shallower towards its outlet." While it is a lake of very striking beauty and charm, it does not seem at first sight to deserve any very special attention from geologists. None the less it is, as I hope to show, a lake calling urgently for further study by reason of the fact that it is the only lake in the British Isles in which the Copepod *Limnocalanus macrurus* is found. To a geologist such a fact may appear, and indeed it has appeared, too trivial to be worth notice; but it happens that this particular Copepod is one whose distribution is so remarkable that its presence in any lake is only to be accounted for in a certain way.

Distribution in Europe.

The facts are these. *L. macrurus* is found in Europe only in lakes bordering on the Baltic, in Sweden, Norway and Finland, while in North America it occurs in all the Great Lakes—Ontario, Erie, Huron, Michigan and Superior, and in some others connected with them. At present, living in the Baltic, in the Caspian Sea and in the Arctic Sea there is a species of *Limnocalanus* distinguishable only from *L. macrurus* by certain small details of which the most important is the shape of the head, and there cannot be any doubt that *L. macrurus* is descended from this species, which is called *L. grimaldii*. In fact, if specimens of *L. macrurus* are compared it will be found that the races of it living in the various lakes differ to some extent, and that every transition can be traced from *L. grimaldii* to an extreme form of *L. macrurus* such as that of Lake Mjösen in Norway. The parentage is certain, and it is only a matter of convenience that the two species are regarded as distinct.

In the Baltic region every lake in which *L. macrurus* lives lies within the area once covered by the great post-glacial fresh-water lake known as the Ancylus Lake which once filled the Baltic depression, and it is also true that in those lakes which lie at the highest level, and are therefore the oldest, the forms of *L. macrurus* living in them depart most from the parent form.

The meaning of these facts can hardly be disputed. The first stage in the history of the Baltic Sea was its invasion, during the retreat of the glaciers, by the sea, there being then a broad opening to the Arctic Sea. The fauna would then be an Arctic one, containing *L. grimaldii* and *Mysis oculata*. As the land rose the communication with the sea was closed and the water became by degrees fresh. In this Ancylus Lake, then, it is supposed that *L. grimaldii* became to some extent modified and adapted to life in fresh water. When, therefore, possibly in Palaeolithic times, the North Sea poured in through the breach in the Cattegat and the Littorina Sea took the place of the Ancylus Lake, these two species survived only in the fresh-water arms of it which are now the lakes in which they are found. They are, in fact, relicts of the Ancylus Lake. *Mysis relicta*, the modified descendant of *M. oculata*, has been able to reach by active migration some lakes which are not themselves relict lakes in this sense, but *L. macrurus* is not capable of active migration and, as it lives in deep water and its eggs when laid sink to the bottom, its transport by wind or birds is most improbable.

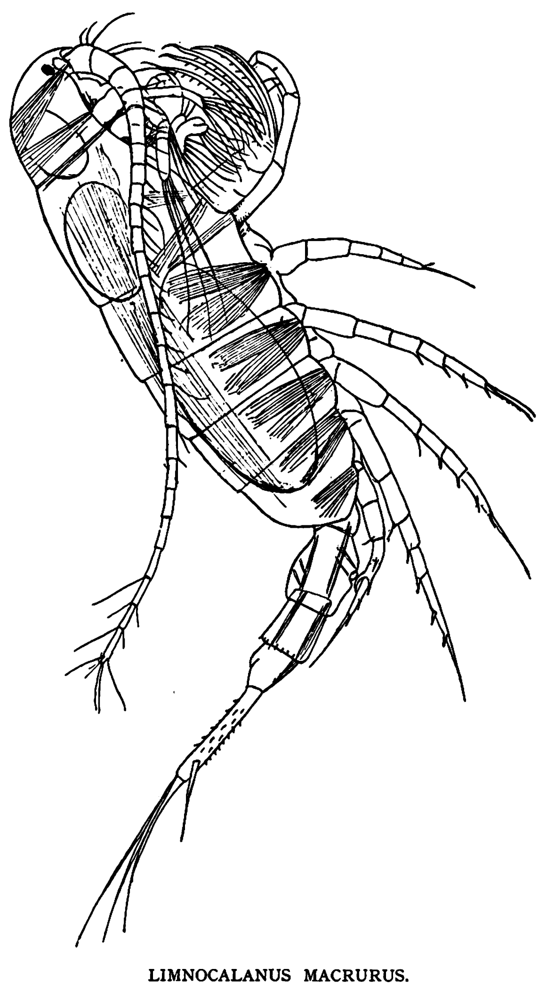
The American Lakes.

We do not know so much about the changes of level of the great North American lakes, but the distribution of *L. macrurus* there (where it is also generally accompanied by *Mysis relicta*) seems to require a similar explanation. It seems to be generally agreed that in the Champlain sub-stage, which is one of the latest phases in the history of these lakes, the sea extended up the valley of the St. Lawrence and filled Lakes Ontario and Champlain, but there is no satisfactory evidence that the marine invasion involved also the lakes to the west. There may have been a connexion by way of the Ottawa river and Lake Nipissing. *L. macrurus* of North America has diverged less from the parent form than the most modified types in Europe, and may therefore be of comparatively

recent origin. Probably the parent form was isolated in the Champlain Sea and reached the western lakes by way of the northern channel, but we have to assume for it rather greater powers of migration than is conceded for the European races.

If, then, *L. macrurus* in the Baltic area, and presumably also in North America, is quite definitely a "glacial relict," its occurrence in Ennerdale demands that this lake also should at some time have been in communication with a sea which passed through a period during which its waters became more or less fresh. There is the problem! The surface of Ennerdale lies at an elevation of about 368 feet, and we have to postulate a submergence of at least that amount to permit of the immigration of the Copepod. Such a submergence would inundate several other lakes, Wastwater for example, and in none of them does *L. macrurus* occur; but we are not concerned to excuse its absence, but to explain its presence.

In order to explain its presence in Ennerdale in accordance with the facts in other parts of the world we have to suppose a sequence something of this kind. The glacial period was one of subsidence, and the Irish Sea existed though it was filled with ice. After the retreat of the ice there was a sea of about its present extent, containing an Arctic fauna, but with water that may have been of relatively low salinity owing to the melting of the surrounding ice. There followed a period of elevation which has left its traces in the form of peat bogs and forests now buried to depths of 60 or 70 feet. The actual extent of this elevation is quite uncertain. Having regard to the probability that the bed of the Irish Sea was covered with a thick deposit of drift, much of which may have since been eroded, Jukes Brown considered that it is possible that an uplift of 150 feet may have occurred and would have been sufficient to unite Wales and Scotland with Ireland in Neolithic times. If this were the case we should have the basin of the Irish Sea occupied by a vast fresh-water lake in which the Arctic species *L. grimaldii* and *M. relicta* may have become adapted to fresh water. The latest subsidence introduced present conditions and drove out or exterminated the Arctic fauna, of which the only traces remaining are *L. macrurus* in Ennerdale and *M. relicta* in Lough Neagh.



LIMNOCALANUS MACRURUS.
A Copepod inhabitant of Lake Ennerdale. (About 50 times natural size.)

This suggestion as to the course of events is not altogether new, for much the same view was taken by Dr. Scharff to account for the present distribution of the genus *Coregonus* in Britain. This genus of fish is of northern origin. The British species occur in Loughs Neagh, Erne and Derg in Ireland, in North Wales, in the Lake District and in South-west Scotland, in all cases in lakes draining to the Irish Sea. Scharff supposes that at the period of maximum post-glacial elevation the Irish Sea was largely dry, but there existed in its deepest parts a great lake in which the ancestral *Coregonus* lived. When the basin was filled again by the sea the fish would be forced to migrate up the rivers and would so reach their present abodes.

So far as concerns these changes of level there is no dispute, but their actual amounts and consequences are matters of speculation. The real difficulty is that of supposing, as it is necessary to suppose, that Ennerdale is a relict of the great Irish lake. It might be suggested that Ennerdale was flooded by the sea during the time of maximum subsidence and that *L. grimaldii* was left behind in it by the subsequent elevation, but it is unlikely that it would have survived in so small a lake, and the evidence from the Baltic is that the adaptation and transformation of the relicts was effected in the very much

larger area of the Ancylus Lake. In order to explain the occurrence of *Limnocalanus* in Ennerdale we have to postulate that the Lake District did not itself share in the elevation which cut off the sea from the depression of the Irish Sea, but that it remained in connexion with the great Irish lake until the latter was again flooded by the sea. This is an assumption for which, so far as I know, there is no evidence.

The problem of the existence of *Mysis* in Lough Neagh is not so difficult, since *M. relicta* has certainly, in the Baltic area, migrated up rivers to some extent, and it is not necessary to assume that the lakes in which it now occurs were at any time themselves arms of the sea. Such an assumption is, however, necessary in the case of *Limnocalanus*, and therein lies the problem. Its solution is not in the hands of the zoologist, but is solely a matter for the geologists—Will they take it up?

Correspondence.

"TELEVISION: PAST AND FUTURE."

To the Editor of DISCOVERY.

SIR,

I read with great interest Mr. Campbell Swinton's very succinct article on Television in last month's *Discovery*. Although I agree in the main with his views, yet I feel that he is a little hard on the various experimenters who have obtained tangible results in this new realm of scientific progress. It is perfectly true, as your contributor states, that many of the devices which appear to be used in television experiments are of considerable age, but the painstaking effort and patient ingenuity required for their integration so as to produce positive results is deserving of very high praise. After all, most scientific "discoveries" are the result of the labours of many investigators spread over a long period of time and it is conceivable that in the first flush of popular success the work of the true pioneers is undervalued, if not momentarily forgotten.

It may be that commercial television will not be realized on the lines of the present experiments, the nature of which certainly suggests that there are grave difficulties in the way of indefinite improvement, but nevertheless we are not able to blink the fact that excellent pictorial impressions have been transmitted over distances exceeding three thousand miles. This is a noteworthy achievement.

I was interested in your editorial comment to the effect that Mr. Campbell Swinton's comparison of television results with other forms of pictorial reproduction was open to criticism. I, too, think the comparison is a little unfair. As your contributor points out, the essence of successful television lies in the transmission of a complete scene or picture in an *exceedingly short period of time*, and here surely is the factor which differentiates it from the other instances which he quotes. A very high degree of delicacy and refinement may certainly be obtained in a photograph, a photographic reproduction in a newspaper, or even in ordinary telegraphic picture transmission; but it must be remembered that all these things represent the results of highly developed craftsmanship and they take considerable time to produce. On the other hand, it is required of television that it should convey, over great distances, a vivid mental impression through the medium of the eye: it must be the instantaneous transmission of a transient scene, for example the changing expression on a human face, *without the interposition of photographic films, plates or developing materials.* If these conditions are to be fulfilled, then obviously the transmission must be extraordinarily rapid.

Television has apparently yielded the required result. I understand that it is still far from perfect as far as refinement of detail is concerned, but the achievement is in a class by itself and must be judged by comparison with results which satisfy similar conditions.

Yours faithfully,

V. E. PULLIN,
Director of Radiological Research.

Royal Arsenal,
Woolwich.

"THE CHEMISTRY OF THE STARS."

To the Editor of DISCOVERY.

SIR,

With reference to my article in your October issue, "The Chemistry of the Stars," I think it might interest some of your readers to know that the progress of science is so rapid that during the period between sending my manuscript to you and its publication, two more molecules have been identified in stellar spectra and several elements.

Spectrograms of the famous variable star, Mira Ceti, when at its recent maximum brightness, revealed bands which have been identified with the chemical compound aluminium oxide, a substance hitherto unrecognized in the stellar atmospheres, and certainly not present in the hotter stars.

In the stars of types R and N, it was stated in my article that the band spectra arose from molecules of cyanogen, carbon monoxide, and hydrocarbons. Two spectroscopists have now put forward evidence for attributing some of these bands to the carbon molecule composed of two carbon atoms.

An exhaustive piece of work at the Mount Wilson Observatory has established with a strong probability the presence in the sun of the "rare earth" elements cerium, lanthanum, neodymium, samarium, europium, and ytterbium; while there is evidence for praesodymium, gadolinium, terbium, dysprosium and erbium, though much less conclusive. The elements illium, holmium and thulium cannot as yet be proved to be either present or absent.

Thanking you for offering me space to publish this "postscript" to my article, I am,

Faithfully yours,

A. VIBERT DOUGLAS.

The Macdonald Physics Laboratory,
McGill University, Montreal.

KING'S COLLEGE, University of London, is this year celebrating the Centenary of its foundation, and an appeal has been issued for £350,000 to enlarge the College and to provide a much needed endowment. The Treasurers are the Rt. Hon. Reginald McKenna and Sir Edward Troup, K.C.B.

Mind in Birds: The Chaffinch as Architect.

By C. J. Patten, M.A., M.D., Sc.D.

Professor of Anatomy, Sheffield University.

*The degree of intelligence in birds is a problem which still gives rise to controversy. Professor Patten here describes a striking instance of avian ingenuity to support the conclusions of a previous article.**

THE typical nest of the chaffinch is a delightful piece of architecture. The little mossy cup—tidy, compact, and gaily decorated with lichens, scraps of fabric, etc.—is made to harmonize so closely with the twigs and foliage of the hedgerows or other building-sites that it frequently eludes observation. Departure from type, within certain limits, is, however, not uncommon: one sees the same thing occurring in the nests of many other species. Variations usually point to a lower standard of perfection, brought about through exigencies of circumstances, or lack of practice and experience on the part of juvenile builders. On the other hand, nests which present aberrant patterns, so pronounced in character that their recognition may become almost veiled, are decidedly rare. In this category I would place here a very remarkable nest of a chaffinch. Supposing it had happened that this curio had been removed, in the first instance, from its natural site; emptied of its contents (eggs in this case); and, furthermore, that no information had been given in regard to the identification of the builders, there is no doubt that the investigator would have been presented with a puzzling picture. But let us turn away from supposition and disclose the real picture, as it stands beautiful and untouched in "Nature's studio."

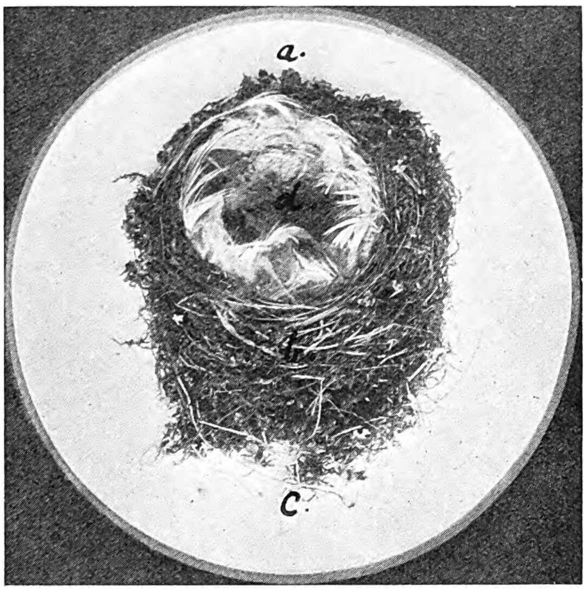


FIG. 1.
THE NEST VIEWED FROM ABOVE.
Observe the large white feathers projecting above the rim of the opening and curving inwards so as to screen the cavity partially from view. a.—Shallow area of wall. b.—Deep area of wall. c.—Tapering pendant. d.—Cavity of nest.

I discovered the brooding female cowering low upon her nest; alarmed at my presence she slipped away noiselessly, and disappeared in an instant amid the adjacent foliage. By her departure she betrayed the presence of four eggs in the nest. Presently a shrill battle-cry—" swink-swink, swink-swink-swink " —rang out in defiant accents. The irate male, her partner, had come on the scene, and drawing rapidly closer, joined company with his mate. He scolded me vehemently, and at the same time afforded an excellent and uninterrupted view of his sprightly form and deportment. Presently his wife showed up from her place of concealment, and commenced to flit anxiously from spray to spray. In this way identification of the birds was made certain, and hence of the eggs and nest. Here, so to speak, was presented one of Nature's own charming little bird-sketches; in truth a lively scene; the principal characters were on the move; Nature operated her own cinematograph; nor had she need of a screen upon which to project her enticing picture. I found on examination, and by making measurements, that there was nothing unusual respecting the eggs. I must confess that at first sight the strange form of the nest seemed puzzling in no small degree. But for the evidence afforded by the eggs and also the birds themselves, I might have been a considerable time arriving at a correct solution of the problem.

The scraps of lichens, neatly adjusted on the outer mossy wall, were characteristic, and suggested that the architects might have been either chaffinches or long-tailed titmice. Indeed, my very first impression, as the nest lay *in situ* (that is to say, before I detected the brooding bird), was that it belonged to the latter

*" Researches on the Mental Factor in Birds." By C. J. Patten. *Discovery*, March, 1927.

species. This idea was strengthened when, in obtaining a profile view after the mother bird had slipped off, I thought that the opening leading into the interior appeared small and as if it were placed towards one end. However, on closer scrutiny I soon discovered that the resemblance was quite superficial. The "dome," the oval contour, and the small circular entrance, all characteristic features of the nest of the long-tailed titmouse, were wanting. The apparent displacement of the opening to one end was due to the presence of a special thickening of the wall—a thickening only constructed on one side. This remarkable additional part was continued downwards below the level of the floor of the nest, in the form of an elongated and tapering pendant. (See Fig. 2, b and c.)

It was evidently more correct to regard the nest as one which had undergone very considerable modification, in its departure from the cup-shaped type. Nevertheless it had retained its open form. In other words it was not roofed in; that is to say it was not an example of the dome-shaped type. The bottom of the cup—distinctly curved in the typically-shaped chaffinch's nest—was here distinctly truncated, and to such an extent that its place was taken by a perfectly flattened surface, constituted only by the inner or lining stratum. The great significance of this marked peculiarity in the form and construction of this part of the nest will be made clear presently. (See Fig. 3, d.)

In endeavouring to put forward an explanation as to how this variation may have arisen, it will be necessary at this juncture to observe accurately the nesting-site selected, together with its surroundings. We may then return to a more detailed description of the form and architecture of the nest itself. For several years the hedgerows had not been clipped; consequently, wide-spreading branches and dense foliage offered very suitable nesting-sites for more than one species. Chaffinches, being numerous in the district, bred freely, especially in the hawthorn. It happened that the year in which I discovered the nest in question, most of the hedgerows in the immediate neighbourhood had been closely trimmed. As a result, the spreading branches and screening foliage, in the midst of which chaffinches were wont to conceal their charming and snug little nurseries, were no longer available. Contributing, however, to the formation of one of the hedgerows was a holly bush, the smaller leaf-bearing branches of which had been left uncut, on account of their stunted growth. But from the more *axial* part of the bush a few *stout* branches had been sawn off. Curiously enough, on the flat surface of a stump from which one of these branches had been sawn away, the feathered architects selected a site for building operations.

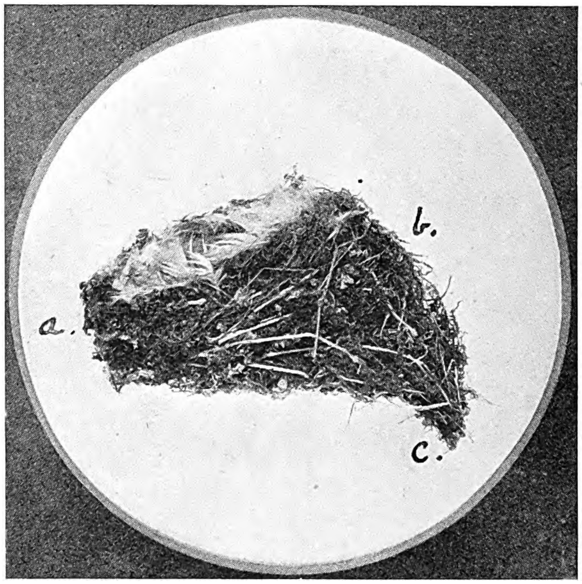


Fig. 2.

THE NEST IN PROFILE.

The uneven depth of the wall, due to thickening and downward prolongation of one area, is clearly seen. a.—Shallow area of wall. b.—Deep area of wall. c.—Tapering pendant.

Here then the nest was erected, having been skilfully constructed and modified in shape in a most remarkable manner, to adapt itself to its particular position and foundation. The cut surface of the holly-stump was almost circular in outline, and measured eight centimetres in diameter, which was a little less than the diameter of the flat under face of the nest. Small branches, bearing numerous leaves, screened the brooding bird.

A more detailed description may now be given. The cavity departed but little from the usual form. It displayed, however, a certain degree of untidiness and want of compactness, two conditions which very rarely occur in the nest of the chaffinch. It gave one the idea that the work had been done in too hurried a manner. Large feathers, white in colour, and evidently belonging to the domestic fowl, constituted the major part of the lining. Several of these feathers projected, and by curving centripetally they curtailed the diameter of the rim of the opening. Consequently, much of the cavity was occluded from view. (See Fig. 1, d.) The depth of the interior reached four centimetres; the diameter measured seven centimetres. When the nest was viewed in profile its very curious shape at once arrested attention. The outside wall, instead of curving gradually inwards and downwards in order to mould off the proper shape

of the bottom of a cup, terminated in a sharply-defined margin which demarcated the wall from the under surface. Furthermore, the wall was markedly uneven in depth from above downwards; at one end it was shallow (Fig. 2, a); at the opposite end it was deep (Fig. 2, b). The presence of the curious thickening, already described, was responsible for the depth. The elongated tapering pendant, which reached below the level of the floor, draped a portion of the holly-stump, which had been jagged and denuded of its bark (Fig. 2, c). But by far the most peculiar, and at the same time instructive, features were revealed when the under surface was subjected to examination. The flatness in itself was quite remarkable. Much more remarkable still was the presence of feathers and other lining material, which could be seen from the outside, in other words from the lower aspect. These feathers and the rest of the lining materials were entirely unsupported below by moss, grass, or any other foundation material! (Fig. 3, d).

Here there seems to arise a clue suggestive of the manner in which the nest may possibly have been constructed. No doubt the feathers of the under surface were carefully interwoven solely for lining purposes. In truth, they were arranged so as to constitute a soft "feather-bed" for the eggs, and later on for the nestlings. This bed of feathers rested directly on the cut surface of the holly-stump. A surface, made level and smooth by the saw formed a substitute for the bottom of the mossy cup of the typically constructed nest. As we might anticipate, the lining material, particularly the feathers, comprised a specially thick and comfortable layer; thereby counteracting the ill-effects which would surely follow if incubation were to proceed in a nest, the floor of which was composed of hard wood.

It seems evident, therefore, from the outset, that the ordinary materials utilized for the foundation of the bottom of the cupped-shaped nest were not brought into requisition. It would appear that the architects commenced operations by building a circumferential rampart on the cut surface of the holly-stump. This rampart (clearly indicated in Fig. 2), is represented by the vertical outer wall of the nest, which in order to give greater security, was built downwards for a short distance over the circumferential aspect of the stump; the tapering pendant already described, being the most salient prolongation. When this part of the building was erected, the birds presumably started to line the interior by interweaving feathers (with the admixture of some wool and other soft constituents), inside the rampart. In this way most of the soft lining materials were brought directly into contact with the smooth level surface of the holly-stump. In this particular case it is hardly conceivable that the builders adopted the method of gathering some of the lining material, and then working it into the nest before the foundation was completed. On the other hand, this would be quite a conceivable method to adopt if a cup-shaped nest were being constructed, having for its support the usual few slender twigs. The lining feathers obviously could be inserted into the interstices of the moss and grass forming the floor of the cup, while the latter was still quite shallow. One could readily understand that as the wall grew deeper, the feathers could be applied *pari passu* to the internal face, these operations being carried out concomitantly, until the cup was completed, the final act being that of decorating the outside wall. But in the case of this strangely formed nest, it is very obvious that light and delicate constituents, such as feathers, morsels of wool, etc., if deposited upon a smooth, hard, level, surface of wood, devoid of a commencing mossy cavity into which they could be intertwined, would be blown away by the slightest breeze.

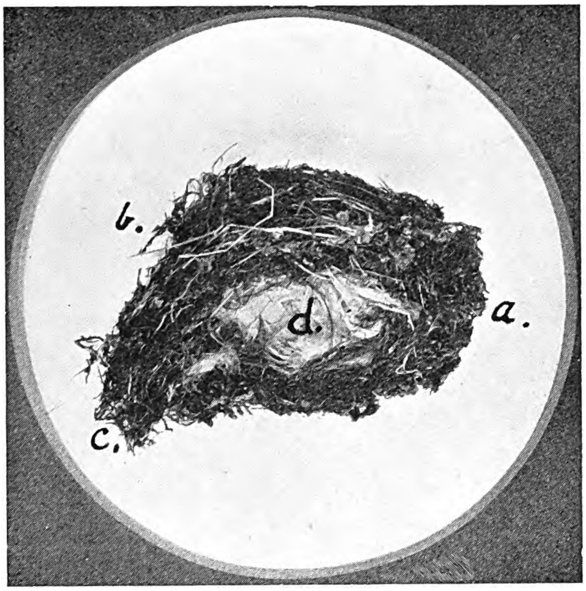


FIG. 3.
THE UNDER SURFACE.
The nest viewed from the under surface, shewing the lining uncovered by foundation material. a.—Shallow area of wall. b.—Deep area of wall. c.—Tapering pendant. d.—Lining composed of feathers and wool.

Even supposing there had been a period of perfect calm throughout the building operations, it is difficult to imagine the lining materials not undergoing displacement, unless the ring-like wall—the rampart—had

already been completed and raised to an adequate height. In regard to the materials composing the nest, it is noteworthy that they were much the same as those usually employed by the chaffinch. Lichens, serving as decorative material, were much in evidence. The foundation, on which the lichens were arranged, was composed of a thick wall of moss interspersed with dry grasses. The lining, made up largely of feathers and wool, was separated from the foundation by a thin intermediate layer, consisting of fine delicate grasses, interwoven with hairs of horses and cattle.

In conclusion, I would add with emphasis that it seems very difficult to deny at least some degree of intelligence and discrimination to the little feathered builders who so clearly departed from the normal method when constructing their nest, in order to suit the special requirements of a most peculiar site. Yet we hear of observers who lean to the idea that birds can profit little or nothing by experience, and are not able to cope to any appreciable extent with adverse circumstances, or even with unforeseen exigencies not necessarily threatening in character.

Among the Stars: A Monthly Commentary.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

THE FACE OF THE SKY FOR DECEMBER.

The chief astronomical event of the month is the opposition of Mars, which is nearest to the earth on 15th December, the distance being 54,000,000 miles. This is half as far again as the distance in 1924, but the increase is more than compensated for British observers by the planet being now so far north of the equator; it nearly reaches 27° north at the end of December, and is then only 24° from the zenith in the south of England. The planet is at the vernal equinox of its northern hemisphere, so both polar caps will be visible; the northern one should diminish rapidly in size as the season advances. This melting of the polar snows can be followed with telescopes of moderate size.

Nursery Rhymes.

The brightest star occulted during December is Eta Leonis, which disappears at the bright limb on 2nd December at 9.55 p.m., and reappears at the dark limb at 10.46 p.m. The chief meteor shower is the Geminids; these may be seen throughout the first half of the month, but reach their maximum on the 11th and 12th; their radiant is then 17° east of Mars, and 7° north of it. In observing meteors their path through the stars should be recorded as accurately as possible, also the time of appearance, and if possible the duration of flight, as this enables the speed to be calculated. Some people repeat a nursery rhyme at a uniform speed when they see a meteor, and estimate the duration by the number of syllables said; there is not time to consult a watch.

Forty years ago the popular writings of the late Richard A. Proctor helped a large number of readers to gain accurate ideas concerning the wonders of the heavens. His daughter, Miss Mary Proctor, has already brought out several volumes of such simple and readable character forming introductions to the sun, comets, etc. A new work, "The Romance of the Moon" (Harper, 7*s.* 6*d.*), deals with the moon; its birth according to the tidal theory of Sir G. Darwin is described; in the same chapter many notable facts are given relating to bores and other tidal phenomena. The author passes on to a study of the moon's surface; she accepts the volcanic theory of the craters, and illustrates her belief by a vivid description of the great eruption of Tarawera in New Zealand, and its effects on the surrounding district. The two following chapters give a description of the chief lunar formations, both as seen from the earth and as they would probably appear to an observer on the moon.

The Moon Rocket.

We have a chapter on "Fact and fiction regarding the moon rocket," in which the author was helped by Professor Goddard. It seems possible that his ideas may be of use in the exploration of the upper air by self-recording apparatus, but quite unlikely that it will be possible for human beings to travel in this manner; a quotation given from Professor Bickerton sums up the grave difficulties in the way: the travellers would get a blow at the start that would be fifty times as violent as the impact of a shell from Big Bertha. In this connexion there is an erratum on p. 166; the 1926 meeting of the British Association was at Oxford, not Cambridge.

The closing chapters deal with lunar weather lore, and lunar folk-lore. Seeing that the author has already published "Legends of the Sun and Moon," I suggest that this section might have been abbreviated, and a little more space devoted to some explanation of the moon's motions. Thus p. 180 refers to the well-known myth that the new moon on her back denotes bad weather; this would be an obviously suitable place to give the simple rules by which the positions of the horns of the moon could readily be found, if desired, for every young moon for a thousand years in the future.

Philips' Pocket Surveyor. Designed by G. C. Sherrin. (George Philip & Son. 2*s.* 6*d.*).

An illustrated booklet describing its various uses is included with this little instrument, which has much to commend it as one for the pocket except for the exposed screw. The booklet says that this "pocket surveyor has been designed to occupy a place in the very wide gap which exists between expensive and highly technical instruments such as the level or the theodolite, etc., and nothing at all." For measuring heights and distances, as well as for making a contoured plan of a small area of ground, it is a useful instrument for the smallholder; but we do not think it will make an "instant appeal" to Scouts, Rovers and others who know ways of performing these measurements with less expensive articles of their ordinary equipment.

A New Route Through Finland.

By Thorlief C. Barth.

Since Finland has become an independent State she has planned and almost completed the construction of a new modern road from the railway terminus at Rovaniemi to Kirkenes on the Arctic sea-board. A Norwegian contributor here describes this route, in an interesting sequel to our recent article on Hammerfest.

THE English tourist going northward along the Norwegian coast seldom proceeds to the east of Hammerfest or the North Cape. The barren coast of Finmark affords little of interest; the sea is wild and rough and there are no more islands to protect against the mighty waves of the Arctic Ocean. The coastal steamer is therefore likely to be nearly empty when it reaches its final port Kirkenes, after more than a week's journey from Bergen. Yet Kirkenes is a name well worth knowing, being now the starting-point for a new and highly interesting route through Finland.

TRANSPORT ON THE PASVIK RIVER.

The small open motor-boat, in which part of the journey was made, was often hauled on land to be conveyed past a waterfall.

The Varangerfjord is generally rough, and the seasick tourist will most probably find Kirkenes an uninviting port, with its tall chimneys and the smoke and noise of a place where iron-smelting is carried on. But only a few miles beyond stand the great and silent forests of the Pasvik River, accessible only along its course; and the impression of these almost endless woods, with the calm lakes of the valley illuminated by the intense Arctic sun, is really a wonderful one. Nowadays it is possible without any great expense and bodily exertion to penetrate what was only some years ago a *terra incognita* to the summer tourist.

We left Kirkenes by motor-car one rainy day in July; but only a very short distance inland the heavy clouds dispersed and soon the sun shone with that peculiar brightness, only known in the north, which imparts to everything—flowers, birds, trees and the whole landscape—an intense, incredible tint, the real attraction of the view in this " Land of Mystery."

The new road by which we travelled was excellent, and in about three hours we reached the glittering surface of the Salmijärvi, the greatest of the lakes n the Pasvik valley. We were now close to the new Finnish frontier; here at Svanvik the Norwegian road ends. It is curious to find small farms and cultivated tracts of land up here where Norwegian farmers from the south of Norway have settled and try to obtain their living in this rough climate.

Further to the south of Salmijärvi we found, with only few exceptions, no resident population. The Norwegian soldiers at Svanvik bid us farewell when we set out from the shore in a small canoe-shaped boat with quite a modern motor; and soon the Norwegian coast disappeared, for the lake is broad, and the Finnish coast but gradually became distinct. In half-an-hour we landed at Salmijärvi in Finland, the starting-point for the new journey to the south.

When the skirmishes between Finland and Russia came to an end in 1920, the final treaty of peace was soon signed, according to which Russia ceded the new " corridor," known as the Petsamo district, to Finland. This now connects Finland with the Arctic Ocean and separates Norway from its former neighbour, Russia. Since then Finland has been busily constructing the great new road which was this year opened for motor traffic along the six-hundred-kilometre route from Petsamo, on the Arctic coast, southwards to Rovaniemi, the terminus of the Finnish railways. Only about fifty kilometres have not yet been completed between Salmijärvi and Pitkajärvi in the Pasvik valley.

The inn at Salmijärvi, where we landed, was primitive and not at all clean, but, of course, much must not be expected of such a place. The eight beds were all occupied, and the mosquitoes swarmed about in myriads that night. Incidentally, night is a wrong word up here in summer;

no night exists where the Midnight Sun shines as clear as at mid-day. We left Salmijärvi early in the morning in a fully-loaded open boat. The motor, however, was powerful, and we made good progress across the glittering waters. Gradually the wind threw up a rough sea, which made travelling uncomfortable; but the lake soon narrowed and we were in the calm river.

The Salmijärvi is the largest of the long series of lakes which form the hundred and forty kilometre stretch of the Pasvik River from the point where it leaves Lake Enare to its estuary in the Arctic Ocean. Between the lakes there are waterfalls which cannot be passed by boats; but in order to utilize this mighty river, which for more than a hundred kilometres forms the boundary between Norway and Finland, the Norwegian Government has built tramways (that is, iron rails have been laid down and a lorry is run over them), thus enabling the boatmen to take the boat overland, launching it again on the other side of the waterfall. All these tramways are built on the Norwegian side of the river, but the Finnish motor-boats are now by treaty allowed to use them for the transport this year, until the road is finished next autumn.

This Arctic river has a peculiar character of its own. For mile after mile it flows on through desolate, endless woods—fenced in on all sides by majestic battered old firs. Now and then the river widens out into a lake, and against the clear skies are seen the fine silhouettes of distant hills and mountains. Thousands of reindeer feed here, and wild beasts of the forest are still common. When we reached Männika, the mighty waterfalls above Salmijärvi, a bear had just killed three cows, belonging to the Norwegian guardsman there, that very night. Under such circumstances it is not easy to settle down and make a living from the land, yet we found that some hardy people were trying to do so.

Passing up the river we were often on the Norwegian, often on the Finnish, side of the boundary—the river being free to the craft of both nations. We were thus enabled to travel quickly, passing three large waterfalls where the motor-boat was towed on the tramway. Primitive as it is derailments are a common occurrence, and the passengers are obliged to take a lift in the derailed boat if they wish to proceed. At last, after four hours' journey, we reached Lake Pitkajärvi where our boat trip was at an end.

On the south side of this long lake we saw in the distance the blue and white Finnish flag waving on the roof of the pleasant looking inn which the Finnish Tourist League has built where the great road ends; and here was civilization! Think of it. Suddenly in this wilderness of hundreds of square kilometres of waste land and trees hundreds of years old we found a modern hotel and the heavy motor traffic of a modern highway. We left our kind and able boatsmen and, after an excellent dinner, we found a huge yellow-blue painted bus standing ready to start on the five-hundred-kilometre tour through the Lapp districts to Rovaniemi.

We sat in comfort in this excellent bus and travelled through a succession of forests which

MAP OF THE ROUTE.
The black line indicates the new road, not yet completed, between Pitkajärvi and Salmajärvi.

stretch without interruption from Pitkajärvi south till. we reached Ivalo on Lake Enare. No tree has ever been cut down in these woods. The old logs lie as they fell yesterday or a hundred years ago, and they remain there till they rot away whilst their silent comrades stand around waiting for their similar fate. We did not see many young trees—these are woods of giants, not of saplings but large tracts are rather more like a graveyard in appearance than a forest of living trees.

For mile after mile the ground is covered with white moss, the food of the reindeer in winter; and this cover of soft moss absorbs every sound and makes these woods almost uncannily silent. Now and again our motor climbed a hill and we had an outlook on to a grand landscape where the glittering river winds its way on like an endless silver shining snake.

It is, of course, monotonous to travel for hours on end through uninhabited tracts like these, and it was a rather tired company who sought rest in the hostelry at Ivalo, on the edge of the enormous Lake Enare. This hostelry is as excellent as that at Pitkajärvi and we found good accommodation here in the heart of Lappland.

A second day's travel remained, and this day afforded us more varied scenery as we now began to approach the cultivated parts of Finland. We were still in the territory of the Lapps, however, and we did not reach the first real settlement at Sodänkyla till after mid-day. This for long has been the

THE PASVIK RIVER.
View taken above the Männika waterfalls, showing scenery in this territory. The river is fenced in on both sides by fir woods

VIEW IN THE PETSAMO DISTRICT
This is a typical landscape of this northern coast-line, indented with fjords.

northernmost tract of fertile farmland. On this day's journey we had to cross several broad rivers which were not spanned by bridges, the motor-car being taken across on ferries. These halts afforded the passengers a welcome opportunity of stretching their legs which, of course, grew rather numb as a result of the long drive in the cold.

After nearly twelve hours' drive we at last reached the top of a hill from which an astonishing panorama suddenly opened out. From east and west flowed two mighty rivers, the Kemiälv and the Ounasjoki, meeting on a large sandy plain where fertile pasture land and cornfields stretch away on both sides. There was no bridge across the broad river and, as many cars were waiting their turn to be taken across by the steam-ferry, we waited more than half-an-hour. Soon afterwards we left our bus outside the hotel at Rovaniemi, the smiling capital of Lappland, situated in the near neighbourhood.

This town is a reallyfascinating place, lying as it does on the boundary between the Lapp districts and civilization. The railway line ends here, and when we entered the train the next day we knew that our trip through the mysterious woods of giant trees and Arctic wastes was at an end. This night at Rovaniemi was the last time that we saw the Midnight Sun, as the next night, at Kemi on the Bothniska Viken, its yellow orb sank beneath the horizon.

From Kemi the tourist might proceed further by railway, either through Sweden to Stockholm or through Finland to Helsingsfors. In either case it is a railway journey of about thirty hours from Kemi, thus affording him an ample opportunity of reflecting on all the strange impressions which the long tour through the lands of the Midnight Sun will have left in his mind.

The Preservation of Chichester Cross.

By A. R. Warnes, F.I.C., M.I.Chem.E.

Reprinted from the "Mond Nickel Bulletin."

A new use for nickel alloys has been found in the preservation of ancient structures, of which the first to be restored in this way is the famous Chichester Cross. This process offers interesting scope to architects.

CHICHESTER CROSS, in Sussex, is one of the finest—if not actually the finest—example of the ancient market cross to be found in Great Britain. Built by Bishop Storey as far back as 1498, it still retains an aspect of beauty and dignity despite the decay which has overtaken it. Indeed, early in this year it would have been difficult to discover in Great Britain a more striking example of a decayed memorial. In addition to the grievous condition, both of the surface and the body of the separate blocks of stone and of the enrichments, various whole members were quite unstable; some of them might at any time have fallen into the road. The deplorable appearance of the exposed surface may be judged from the photograph opposite, and it is to be realized that only one of the eight elevations is here shown. Even from the street it was evident that the fabric was in a serious condition, but closer examination amongst the flying buttresses and centre shaft disclosed a state of dilapidation which was a source of dismay to everyone concerned.

In the course of various earlier efforts at restoration a great weight of iron had been introduced into the structure in the form of dowels, cramps, ties, etc.; this was specially evident in the eight flying buttresses, which architecturally are merely ornaments. From a mistaken idea that they have a structural justification, and because many of the stones had decayed badly and in places had fractured, earlier restorers had placed iron strap supports along the length of their under surfaces, as shown in Figs. 1 and 3. The straps were fixed by means of bolts and nuts passing at equidistant positions right through the buttresses to the upper surfaces. Rusting of the iron had progressed to such an extent that in places the original metal had all but disappeared. The rust occupying much more room than the metal, the stone had been split clean through, as shown in Fig. 1, in which may be seen the head of the sunken bolt whose rusting has caused the crack.

A similar state of affairs was discovered in a great many other members, such as ramps, pinnacles, transoms, mullions and cappings. As a result the stonework of all the affected members was dangerous either to passers-by or to the building itself. Much of the stonework had been split off and later restorers had filled in and covered over the cracks and cavities with cement-sand rendering, which both directly and indirectly had been and still was promoting further decay. Fig. 1 shows the appearance when some of this rendering had been removed.

Such was the situation which the author had to disclose. The next task was to advise as to the best methods to adopt to avoid further damage and

FIG. 1.

FIG. 2.

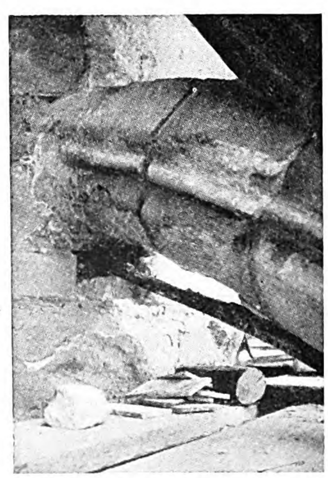


FIG. 3.

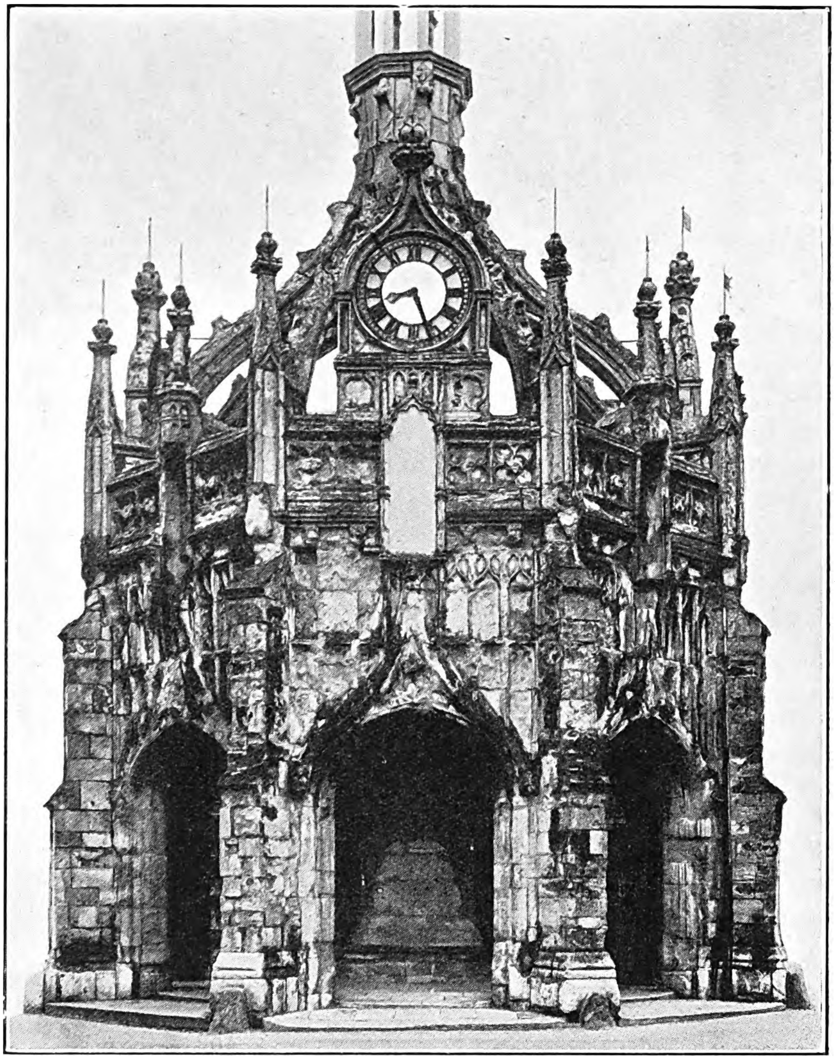
FIG. 4.

VARIOUS PORTIONS OF THE CROSS BEFORE AND AFTER RESTORATION.

to preserve as far as possible the existing old stonework. Previous experience had shown that the employment of some metal was unavoidable in such problems of fabric preservation, and fortunately this had led to very full investigation of the subject in question.

The difficulty was to obtain a metal which in small section should possess considerable strength and at the same time resist not only normal atmospheric corrosion but also the special and varying chemical attack to which it will assuredly be exposed in such situations. A long and, it is considered, exhaustive series of tests were carried out both on the laboratory scale and under practical outside conditions, with every metal and alloy which gave any promise of success, as a result of which it was unhesitatingly decided to adopt an alloy specially manufactured by Messrs. Henry Wiggin and Co. of Birmingham.

This alloy was one of nickel, chromium and iron, containing over fifty per cent of nickel, and it was found to possess not only the necessary strength, stiffness and extreme adaptability, but it also retains its valuable properties, no matter what special treatment it receives at the hands of the constructional engineer.



CHICHESTER CROSS BEFORE RESTORATION.
The deplorable condition of the stonework was partly accounted for by the use of iron in previous repairs, which had caused cracking and subsequent damage of the surface.

A few comments upon the illustrations will show the efficacy of its use. Fig. 2 shows the top portion of one of the buttresses in its decayed condition. The dark triangular portion (spandrel) to the right is the brick infilling rendered over. Fig. 3 shows the upper portion of a buttress with the spandrel (top centre) cleared of brick infilling. It exhibits well the end of the iron support, nearly rusted away where it enters the central shaft. The stone decay which has taken place immediately above this iron is also clearly indicated. Fig. 4 shows a portion of one of the buttresses in the restored state with the iron support free from it and being no longer required, ready to be entirely removed. It also shows how the original stone has been preserved in a condition pleasing to those who value historical monuments. It will be seen that this cross affords a good example of the value of the alloy in question for purposes of restoration. It has been used with equally satisfactory results on some of the Norman work in the precincts of Canterbury and in the Norman arcading at Boxgrove Priory.

Restoration work, however, by no means exhausts its architectural usefulness, and at the moment it is being employed not only on modern buildings which have fallen into decay but also on buildings in course of construction. In addition it is being found of great service for the maintenance of plaster structures where it is important that no stain of any kind shall be in evidence. In the author's opinion this alloy opens such a wide field of possibilities that architects would do well to give it their most earnest attention.

The Sixpenny Library: Second Review.

By A. R. Edge, B.A.

The following review deals with the scientific titles published in Benn's Sixpenny Library since the first notice of this series appeared in May and June last. As previously, this article is in place of single reviews.

"PERCEPTION and experience," writes Strabo, one of the earliest Greek geographers, "alike inform us that the earth we inhabit is an island: since whenever men have approached the termination of the land, the sea, which we designate Ocean, has been met with: and reason assures us of the similarity of those places which our senses have not been permitted to survey. . . . And as to what remains unexplored by us, ... , it is not much, ..."

From earliest times a theory that accounted for a few observational facts was only reluctantly discarded for a later one in more perfect agreement with a wider experience. Especially since the Renaissance our knowledge of the universe has grown by leaps and bounds compared to that gained in all the former ages in which man lived, yet no one to-day would be bold enough to say of any branch of knowledge what Strabo said of the then known world. Our manner of enquiry and deduction has become more critical through experience, which makes an up-to-date survey of specialized knowledge such a valuable asset both to the specialist and the interested general reader.

Now, whatever the interest of the general public—whether archaeology or one of the many branches of science, literature, law, history or politics—there are books written specially for this series by the foremost brains in their subject at a price within everyone's purse. The arguments that one lacks both time and means for study is nullified by these and similar publications.

Oceans and Rivers.

In "*Oceans and Rivers*" Miss E. G. R. Taylor has given us an account both of the various ideas that man has held respecting his geographic environment from earliest historic times until the present day, and a scientific treatise on the basis of modern knowledge and of the problems of hydrography. The problems of the regimen, or seasonal variation, of rivers is discussed in detail. This has been of great importance from a historic standpoint, because of the ingenious theories brought forward by the ancients to explain these variations in the fertile valley of the Nile. Confusion was introduced by the fact that "many old writers never realized the essential relation between the river and the slope of the ground which determines its course; . . . it was thought quite natural that a river should divide and flow in opposite directions, as the Nile indeed did in the delta section." Thus the early Arabs believed the Senegal to be a tributary of the Nile!

Of unusual interest is the account of the "River in Use." A river system obviously functions as an organic whole, but it is regrettable that in the modern control of waterways this fact has almost always been forgotten or ignored. In this the organization of modern civilization is far behind that of Babylon or Egypt of old. Historical study has revealed that in these ancient kingdoms the successful use of the river lay altogether in unified control. Many examples are given to show the advantages of the desired international control of rivers; but from Britain itself we may take as an example a river where unified control would be a distinct advantage—that is, the Thames. Only recently has the London public become aware of the real danger of floods in the heart of the Metropolis as a result of the controlling authority of an upstream section not being responsible for the waters below a certain point.

Nutrition and Dietetics.

Nutrition, dietetics, and heredity are subjects of much popular interest and appeal. Topics of conversation, dependent on the Theory of Evolution for confirmatory evidence, have long been, and will long continue to be, the centre of much biased argument, to the detriment of that happy and contented frame of mind which is essential for epicurean enjoyment. *Heredity*, by Dr. F. A. E. Crew, and *Nutrition and Dietetics*, by Dr. Cathcart, should then be of even more general interest than many of the scientific sixpennies. Dietetics is a subject over which much controversy rages at the present time. There are competent, prominent men who advocate a period of semi-starvation as a panacea for all ills; there are still many who stand by the roast beef and ale of merry England. In this, as in all other cases, the fad of the cranks is inevitably exploited by the professional "quack," whereas under expert medical advice diet may be so modified to effect a cure.

Dr. Cathcart clearly states that the universal perfect diet is a will-o'-the-wisp.

"Eat all things nature doth bestow,
It will amalgamate below,
If the mind says it shall be so.
But, if you once begin to doubt,
The gastric juice will find it out:
Calm courage conquers sauerkraut;"

although he ends with this good advice, yet his quantitative analysis of the essential foodstuffs—proteins, carbohydrates, fats, vitamins, salts, and water—and their calorie value will, we feel sure, strengthen the arguments of some of our food cranks, in their own minds at least.

Professor V. H. Mottram, in a recent address to a conference of the Institute of Industrial Welfare Workers, mentioned that no one who favoured a mixed diet need worry about vitamin-content or calorie value so long as the diet was plain and wholesome. The poorer classes who had to economize in food were the greatest sufferers, since cheap foods were bad as a dietary basis, although admirable in conjunction with other things. Economy on energy producing foods such as fat, meat, dairy produce, and cereals, is wrong.

It is instructive to be reminded that as long as eighty years ago an early continental writer wrote, "The lion is so fierce and so powerful, not only because it is built as a lion, but also because lion's blood flows in its vessels. Lion blood is not derived from twigs or roots, but from meat. The cow is as quiet as she is, not only because she is built as a cow, but also because quiet grass or hay blood flows in her vessels. . . . Therefore, he who has too much energy should eat vegetable matter like a cow, and he who has too little energy should eat meat like the lion."

Heredity.

Chromosomes, insignificant though they are in size, are rightly classed as the most important content of the animal body. Each human gamete carries twenty-four of these infinitesimal structures, and from generation to generation they transmit those characters which make each human being what he is—athlete, genius, idiot, or crank. In this book, *Heredity*, the reader will learn of the growth of our knowledge in the transmission of hereditary characters—how the germ-plasm and original Mendelian theories were insufficient to explain the growth of our knowledge. At present the most important application of the new knowledge of inherited characters is in the realm of animal- and plant-breeding, but although the problems of agriculture are many and varied the number and length of experiments are small. It seems almost certain that permanent improvement of stock cannot be effected through an improved environment alone.

The problem of hereditary characteristics in the human race is fast coming to the fore, and it must be approached without reference to conventional moral codes or fanatical zeal on the part of the "eugenic" or religious fraternities. In almost all civilized countries there has been an extraordinary increase in the size of the population—a differential increase with a very large comparative increase of the less sturdy stocks. The inauguration of the "International Union for the Scientific Investigation of Population Problems" in July last shows that the civilized nations of the world are looking ahead. Dr. Crew will preside over one of the Commissions appointed by the Union on "Differential Fertility, Fecundity and Sterility." It is interesting in this connexion to read of the withdrawal of the sterilization clause amongst others in the Mental Defectives Bill lately passed by the Government of New Zealand. Public opinion is still too conservative to be scientific. The solution of this problem is partly economic, but the desired improvement will not come until (1) the standard of the ideal has been shown to be biologically attainable; (2) the ideal environment has been defined and secured; (3) mankind recognizes that man can and must control his own further evolution.

Physics and Botany.

Two further books, *Introduction to Physical Science* and *Introduction to Botany* fill the long-felt need for a brief survey of the scope of the work included in two more branches of science.

To many men the conception of relativity is as a closed book. This may partly be due to the confused ideas that many have about the essential concepts of physics, which are here clearly defined. At the close of his *Introduction to Physical Science* Professor James Rice writes:—"If it serves to awake interest and promote further study of a branch of human knowledge not too well cultivated by the layman, it will have achieved something useful."

Botanists are continuously faced with many problems which affect both the necessities and luxuries of our civilized life. The world's annual loss from the scourge of plant pests has been estimated as in the region of £300,000,000. The American wheat "failure" in 1919, when almost half the crop was destroyed in many areas, and the pest which is now seriously affecting the home lavender industry, show the extent of an isolated epidemic. In order to combat this huge annual loss it is essential that the place of plants in the natural economy of the world

should be better understood by those that grow them—in order that the botanist may more easily gain the co-operation of the agriculturalist in his research work. This book does not quite give that desired outline from the growers point of view, although it contains much useful information for him.

English Folklore.

It is true, indeed, that "the proper study of mankind is man." In such a study as folklore everyone may be an observer, even though he play a very humble part in collecting local data. In the earliest days of the study of folklore Andrew Lang in his *Adventures Among Books* states ". . . folklore . . . which to many seems trivial, to many seems dull. It may become the most attractive and serious of the sciences." It must be remembered that astronomy has grown from the superstitions and conjectures of the astrologer, and the study of folklore is even yet young.

The development of all human institutions from the Palaeolithic village to the U.S.S.R. often seems a dull story to all but a few, yet the study is full of surprises—folklore is a wide and interesting study embracing all the ancient customs of mankind.

In *English Folklore* Mr. A. R. Wright limits his survey of the subject to that known to be surviving in very recent years. It may surprise many readers to learn of the many local festivities and rites still practised year by year; yet it is hardly fair to the reader to bring forward the case of three *lunatic* women in Nantwich spreading a rich supply of food beside the mummified body of their mother as an echo of a very ancient custom.

Science and Reality.

From a survey of geometrical and astronomical considerations from a historical standpoint Dr. Sampson in *Science and Reality* passes on to a survey of our experiences of the universe. He quotes Lord Balfour in his address to the British Academy in 1925, who states in general terms a "string of loosely expressed platitudes that we can neither prove nor reject"; but which would repay perusal by everyone. "Whatever else they may be," the author writes, "we can recognize in them the whole and sole philosophical armoury of the average scientific man." There is an excellent summary of the present philosophical position to which scientific theory has brought us. The basis of all considerations is that no test can be devised that makes "the existence of other persons than myself" more than a hypothesis—workable, yet convenient. *I think, and so I exist*, in the philosophy of Descartes, is the greatest depth so far fathomed by any great thinker.

Origins of Civilization.

The Origins of Civilization, by E. N. Fallaize, *Man in the Making*, by Dr. Marett, and *The Origins of Agriculture*, by H. Peake, form three volumes of exceptional interest to the anthropologist. Man has been described as a "tool-making" animal in order to distinguish him from all others, although apes have been said to have "invented" tools in order to escape from their cages. It is extremely difficult to lay down any hard and fast rule or to be sure of our own opinion when we agree that such and such fossil skeletons are human or simian. The dawn of civilization broke with the evolution of Homo sapiens in obscure antiquity, and the date has, within the past few years, been pushed further back in the remote ages owing to the general acceptance of the eoliths as of human origin.

It must be remembered that structure, function, and culture, interrelated in development, react one on the other throughout the history of a race. Achievement in art and some primitive conception of religious belief mark the close of the Palaeolithic period, of which time we know nothing definite about man's social organization. Man was then on the point of entering upon that stage in which he gathered from agriculture and domestication an increasing yield of food and the luxuries attendant upon a settled life. Mr. Fallaize has written a masterly summary.

The Origins of Agriculture continues the story from this point in the history of mankind. Man cannot have attained to civilization until he had learnt to practice agriculture, resulting in a settled life in one place; but he need not have passed through the hunting and pastoral stages before he learnt to derive benefits from agriculture. There is a great deal of evidence to be adduced in favour of the origin of agriculture both in Asia and Africa; the writer, from archaeological and botanical evidence, being inclined to the former view; whilst the manner and date of its origin is still and must remain a debatable question.

In *Man in the Making* Dr. Marett pleads for a true understanding of the province of anthropology by both its opponents and supporters. Its function is first and foremost to enlarge the mind—and its study must be carried on in order that men may become more civilized. The place of magic, religion, marriage, government, law, communications, property and morality are all discussed in their relation to man's progress.

Book Reviews.

The Shadow of the World's Future. By SIR GEORGE HANDLEY KNIBBS, C.M.G. (Ernest Benn. 10s. 6d.).

(Reviewed by Sir Bernard Mallet, K.C.B.)

The problems raised by Malthus' work which created so great a stir more than a hundred years ago sank more or less into oblivion in the nineteenth century, owing to the industrial revolution, the development of the vast territories of North America, the gold discoveries and the march of invention, which caused an unprecedented increase of our Western population and provided the means for their support with a rising standard of living. It is only in the last thirty years that a reaction from this state of feeling has set in, and increasing pressure has begun to show itself in a check to the process in the rise of real wages in Europe, in stringent immigration laws, in local occupational congestion and labour troubles, and in the attention drawn to the contrast between overcrowding in some regions and empty spaces in others. One of the many signs of this reaction is the publication of this striking little volume by Sir George Knibbs, sometime the Australian Commonwealth statistician, who, both for learning and philosophic insight, stands high among those who have devoted themselves to the study of population problems.

The estimates which he publishes in the forefront of his book of the possible growth of the world's population have startled the public, who, however, quickly consoled themselves with the thought that nothing would happen in their time. But nothing is more certain than that, if the rate of increase which has characterized the period since 1845 should be maintained, in which there is nothing improbable, the present population of the world will be doubled in little more than one hundred years, and that in this comparatively short space of time there will arise a situation in which the difficulties of economic adjustment both internal and international, pressing enough even now, will be immensely enhanced. Sir George Knibbs indeed considers that we are rapidly approaching numbers which make the problem " a stupendous, nay even an appalling one." But though experts and scientists may be alive to the need of facing the problem, the public remains unmoved in spite of the fact that the growth of population has a greater effect in transforming the conditions of human existence than any other single factor. But, like the effect of the abundance or scarcity of the precious metals on the level of prices and wages, it operates unperceived by all but scientific experts, and the masses of mankind, even in civilized communities, remain insensible to what appears to them an inevitable process of nature. A book like this is calculated to make them enquire whether by taking thought man may not yet, to some extent, become master of his fate, and do something to avert the calamitous struggles, not only between national units, but between races of every colour which many foretell as the result of increasing pressure on the natural resources of the habitable globe. For one of the first results of population increase will be to intensify the process by which throughout history the more vigorous and hardly pressed peoples have sought to possess themselves of the comparatively vacant areas on the earth's surface. And sooner or later the question which Sir George has more than once formulated will have to be faced, whether it is better that there should be larger numbers and a more modest standard of living or " fewer numbers and lavish living."

Sir George Knibbs has suggested many of the questions which call for solution in any serious study of the population question. What, for instance, should constitute the norm of the standard of living, and how should it be ascertained and measured? What is the " optimum " population for any particular country, or for the world as a whole? How can the data best be obtained for estimating the possible production of cereals and food-stuffs on the earth's surface? How can the present prodigious waste of minerals, coal, oil, iron, etc., be controlled? What are the causes, biological, economic or psychological, which underlie the growth or decline of human populations? The effects of miscegenation between different races? The truth as regards difference in fertility between social classes in a community and between different nations and races, and its probable ultimate results, ethical and political?

The important practical conclusion to which all this tends is the necessity for intensive study of such questions. The problems are much more than sectional or national; they are rapidly becoming world-wide with growing interdependence and intercommunication; and they can only be studied in co-operation with other countries. " An international review of all the greater questions affecting mankind seems to be now a *sine quâ non*." And so on. It is needless to multiply quotations. Nothing could time better with the work to which the experts from many different lands and continents have set their hands by the foundation last July, in Paris, of the " International Union for the Scientific Investigation of Population Problems "— a work with which Sir George Knibbs is himself heartily in sympathy. It may be added that the Union is based on national committees in all the countries adhering to it, and that a British Population Society was accordingly formally constituted at the end of last October, details of which will shortly be made public.

The Seas. Our Knowledge of Life in the Sea and How it is Gained. By F. S. RUSSELL, D.S.C., B.A. and C. M. YONGE, D.Sc., Ph.D. (Frederick Warne & Co. 12s. 6d.).

The two authors of " The Seas " are both well known for their researches in marine biology, and their various experiences in these fields form an ideal combination for the production of a popular introduction to the modern science of oceanography. Such a book was much wanted and this want is supplied in a most attractive and original form. The style is so simple that an intelligent child will enjoy it, and so much not usually found in text books and natural history books is included that adults, both laymen and specialists, will read it with pleasure and profit.

Many volumes appear on the subject of the sea-shore in all aspects, but very few on the sea and its inhabitants, and although there is a chapter on the sea-shore the whole work is mainly to do with the sea. " Our Knowledge of Life in the Sea and how it is Gained " is the sub-title. Life in the sea, composition of the sea and sea bottom, tides and currents, experimental work, fisheries and other marine industries—all are given a certain amount of room, and methods of research are fully discussed. From the introduction we proceed to the descriptions of the conditions of life on the sea-shore and on the sea-bottom. Further chapters deal with swimming animals, drifting life, boring life, coral reefs, colour and phosphorescence, feeding of marine animals, sea water, ocean seasons, methods of oceanographical research, the sea fisheries, the shellfish industry, fishery research and products from the sea.

The book is profusely illustrated by maps, diagrams and figures, many of them coloured and the greater part original. These

original photographs and drawings are excellent. To instance only a few of these: there is a wonderful coloured picture of a crab casting its skin, an actual photograph of the living animal, rarely caught in such an act, other beautiful photographs of animals on the shore, X-ray photographs of a fish and of wood bored by the ship-worm, and delicate colour sketches of fishes' eggs and other planktonic organisms. The successful reproduction of both coloured and uncoloured figures throughout is noteworthy.

Mr. Russell's chapter on the plankton is specially interesting as it is by an expert whose own work is mainly on that subject, and the same is to be said of Dr. Yonge's accounts of the ship-worm and of the feeding of marine animals. It is, however, difficult to pick out good things from a work which is wholly good, and the reader must chose for himself from the variety offered. It is certain that the book gives one exactly the right idea of life in the sea in general and all that it embraces, showing that fisheries work in its broadest sense although primarily to do with fish in reality has to do with everything in the sea, the chemical constituents and floating life, the bottom life and the swimmers both vertebrate and invertebrate, and that as the plant is dependent on the salts and gases in the sea, so is the animal dependant on the plant. We are now beginning to realize what is involved in true fisheries research, and that marine laboratories and research vessels as well as trained biologists and hydrographers are needed in order to help the fisherman to make the most of the great industries of the seas.

The authors, who are at present in Australia on the "Great Barrier Reef Expedition," are to be congratulated on the successful production of this valuable work which is recommended with every confidence to all readers of *Discovery*.

MARIE V. LEBOUR.

Buried Treasures of Chinese Turkestan. By ALBERT VON LE COQ. Translated by ARTHUR BARWELL. (George Allen & Unwin. 18*s*.).

Geographical and historical conditions have combined to make Turkestan one of the great archaeological treasure houses of the world. Within the last thirty years, the researches of explorers of many nationalities, but especially of Dr. Sven Hedin and Sir Aurel Stein, have opened up new vistas of knowledge of which the extent is not known even yet. Our information relating to the racial movements of inner Asia has been greatly extended, and our conceptions of its ethnical and political history have been profoundly modified. Over twenty new languages have been discovered—some of which were not even known by name before—in documents which preserve among them not merely an Aryan tongue, but one which belongs to the Europeans and not the Asiatic groups. An entire literature of an early heretical sect or religion, Manichaeism, which survives here alone, has been recovered, and a vast store of examples of Greco-Buddhist art, retrieved from the ruined temples and monasteries of the desert, has revolutionized our knowledge and appreciation of Buddhist art.

These are some only of the achievements of the expeditions of the present century, of which the general public as yet knows very little. The broader aspects of these discoveries have still to be exploited. Dr. von Le Coq's book is therefore a welcome addition to the more popular of Sir Aurel Stein's works. He describes two of the four German expeditions which between 1902 and 1914 worked in the oasis of Turfan in north-eastern Chinese Turkestan at a point where two ancient caravan routes meet. His book is a well illustrated popular account of how and where the expeditions worked, and gives the reader a very good idea of general conditions, of the character of the remains and the types of people, while avoiding the excessive and technical detail which would be inappropriate in a book of this type.

E. N. FALLAIZE.

Birds and Their Young. By T. A. COWARD, M.Sc. Illustrated by ROLAND GREEN. (Gay & Hancock. 10*s* 6*d*.).

This volume forms a companion to "Birds One Should Know," written previously by the Rev. Canon Theodore Wood. Both are most attractive gift-books, and the name of Roland Green affords a guarantee of the excellence of the illustrations. The coloured plates are charming, and the frontispiece of 'Robins and Young' has been happily chosen. We are struck, not only with the colouration and deportment of the parent-birds, but also with the sparkle in the eyes, and robins' eyes do sparkle. A distinctive feature of the plates is the manner in which they are mounted on antique dark-shaded boards. To many of us interested in art, Roland Green's untouched reproductions in black and white are perhaps even still more pleasing. Mr. Coward is a practised writer, crisp and vigorous in style: and in this volume he has kept well up to the scratch.

Ornithology has gone and is still going apace. Nowadays we take a wider outlook; consequently our studies have become much more popular. Books dealing with the avi-fauna of this or that county—perchance of two adjacent counties—fail, in a great measure, to grip the attention of the ornithologist of to-day, though they may have done so a generation ago. With extended knowledge (which, thanks to educationalists, has been inculcated in the school-boy or girl), we find ourselves very interested in flight, language, courtship, display; in the behaviour of the infant, of backward and precocious youngsters, in the behaviour of the parents in defence of their offspring; in battle, menace, camouflage, and decoy; in migration and the homing faculty; in the scope of mentality, in profiting by experience, and in many other studies which offer problems most fascinating to follow up. Along these lines Mr. Coward has presented the reader with a most thoughtful general survey. A perusal of his delightful chapters convince us of their high educational value. Author, artist, publishers, and delineators, merit our grateful thanks.

C. J. PATTEN.

Spirit of Delight. By GEORGE MCLEAN HARPER. WOODROW WILSON. Professor of English in Princeton University, U.S.A. (Ernest Benn. 12*s*. 6*d*.).

Thomas Hardy once noted some lines from Thomson as an "instance of a *wrong* (i.e. selfish) philosophy in poetry:—

'Thrice happy he who on the sunless side
Of a romantic mountain . . .
Sits coolly calm; while all the world without,
Unsatisfied and sick, tosses at noon.'"

Applying this standard to the writing of poetry, as well as to prose, the mere creation of something beautiful is not enough; its full purpose is achieved only when it influences the lives and ideals of the artist's fellow beings.

Professor Harper does not expressly state this thought in any of his essays, which deal with great writers, their philosophy, and with certain of his own travels, but in all of them it is

implied. " In all beautiful art," he remarks, " in all scientific discovery, in all creative activity whatsoever, the spirit of delight is manifest," yet it seems paradoxical that so much imaginative literature is extremely sad—" sadder," he hopes, " than life itself is for most people." The secret, however, is revealed by Keats, when, in writing of Melancholy, he says :—

" She dwells with Beauty—Beauty that must die
And Joy, whose hand is ever at his lips
Bidding adieu."

—so confessing it vain for these writers to try to persuade us that they are really unhappy.

A similar basis may be discovered in the novels of Hardy, who is often thought to be pessimistic and joyless. In the early pages of " The Return of the Native " he describes the rugged permanence of Egdon Heath, " a place perfectly accordant with man's nature—neither ghastly, hateful nor ugly ; neither commonplace, unmeaning nor tame ; but, like man, slighted and enduring ; and withal singularly colossal and mysterious in its swarthy monotony." In a thought-provoking essay Professor Harper links Hardy with W. H. Hudson, and remarks that " their relation to nature is the fundamental fact for both of them, the ground of their interest in life, their happiness, their terrors, their sympathies, their knowledge of things and of men, and finally of their philosophy or religion." They could make no such distinction as Emerson, with his Puritan antecedents and background, between a " law for thing " and a " law for man." Thus Hardy is revealed as an early interpreter in the realm of literature of what ecclesiastics, no less than scientists, are even now only beginning to perceive and preach, that there is no necessary conflict between religion and natural law.

Another essay couples the names of Eugénie de Guérin and Dorothy Wordsworth, a sister each in her different way and times living for the love of a poet brother. Coleridge, Matthew Arnold and Dante are other subjects for the Professor's pen ; and in a concluding reference to the delightful travel sketches—" Mycenae " and " Two Old Fogies in Holland "—a word of appreciation must be paid to the hand of Mrs. Harper, to whom, the author tells us, their " best part " is due.

Our Wonderful Universe. By Clarence Augustus Chant, Professor of Astrophysics, in the University of Toronto. (Harrap & Co. 5*s*.).

Professor Chant's book may be recommended as a delightfully simple, yet sound, introduction to astronomy. Among original points in it may be mentioned the proof of the earth's rotation that is afforded by the gyro-compass ; the fact is mentioned that this is the only form of compass available in a submarine, since " a magnetic compass is useless if it is completely surrounded by iron." The huge iron weight drawn on p. 56, surrounded by t..y weights, helps the mind to grasp the immense preponderance of the sun over the planets, while the picture on p. 61, " finding the distance across a river," should help beginners to grasp the method of finding parallaxes. It is of some help to realize the huge distance of Alpha Centauri when we are told that while a cobweb reaching to the moon would weigh only ten pounds, one reaching to that star would weigh 500,000 tons. We may add the further fact that if this mighty distance be represented by one inch, then Hubble's furthest spiral nebulae would be six hundred miles away.

The illustrations are excellent and include many recent photographs of the sun, moon, planets, nebulae, etc. If a word of criticism may be allowed, we note that the two little sky travellers in the picture on p. 47 are made to see more with the naked eye at a distance of 10,000,000,000 miles from the solar system than a powerful telescope would show ; also it seems a pity to represent the " Martians " on p. 104 as such impossibly hideous creatures. Again, the high tilt of the equator of Neptune shown in the picture on p. 122 is wrong ; it would be better to interchange it with the picture of Uranus on p. 120. There is an erratum on p. 43 : on 1st January the sun is in the Archer, not the Scorpion.

A. C. D. Crommelin.

Great Britain. Essays in Regional Geography. By Twenty-six Authors. Edited by Alan G. Ogilvie, O.B.E., M.A., B.Sc. (Cambridge University Press. 21*s*.).

This series of essays was published under the auspices of the British National Committee for Geography to mark the occasion of the twelth International Geographical Congress at Cambridge earlier in the year, and to present to foreign delegates a synopsis of British regional geography by British geographers.

The series certainly gives strangers an excellent introductory account of British geography, and comprises a very readable volume of general interest to all who desire to know more of the natural resources of our Island, their distribution, the problems they present to efforts made for their exploitation and their connexion with the problems of population and national well-being—as well as a very helpful guide to the serious student of British geography.

The variable climate of this island, with its constituent causes, so detested by those who come " from sunnier and more settled climes," is described by Mr. H. R. Mill in the opening chapter to avoid repetition and confusion in the following sections. For the purpose of description, England is divided into nineteen and Scotland into four sections—each mainly a geographical province, though the division of the English Midlands is somewhat arbitrary. Individual geographers have described the region with which they are most familiar in the fullest and widest manner that space will allow ; due attention being paid to the geological, historical and industrial factors of the region in regard to their relative importance. Though somewhat confusing in detail, the diagrams showing the relation of the geology of the south-eastern region to the topography, agriculture, population and industry are a useful and novel manner of representation.

Iconoclastes, or the Future of Shakespeare. By Hubert Griffith. " To-day and To-morrow " Series. (Routledge. 2*s*. 6*d*.).

It was quite natural that Mr. Griffith, being a dramatic critic, should have confined himself to the production of Shakespeare's plays and not have concerned himself with the critical works which have yet to be written measuring them with the foot rule of the pedant's mind. The writer's thesis is that although Shakespeare has no present on the stage, he has a future there. The profound tediousness of the plays as acted by long-whiskered and ranting actors who, when they don " costume," affect the most irritating and silly mannerisms, has killed any desire of the general public to go to performances of the plays unless acted by a bevy of " stars."

If the works of Shakespeare are for all time they are as much for the present as the past, but, although essentially modern,

the dreariness of "costume" production has hidden this quality like a needle in a bundle of hay. Mr. Griffith, therefore, has made the discovery sufficiently revolutionary to be reactionary, that to preserve their immortal aspect the plays should be performed in modern dress. In the eighteenth century the plays were performed in eighteenth-century costume, a fact the writer omits, but even then they were not popular. Few who saw the modern dress *Hamlet*, however, could have failed to be impressed by its extreme beauty. Mr. Griffith may have overstated his case, but intelligent modern dress productions will certainly have the effect of setting new standards for the production of Shakespeare's plays.

Geological Maps. Their history and development with special reference to Wales. By F. J. North, D.Sc., F.G.S. (National Museum of Wales and the Press Board of the University of Wales. 1s.).

In the *Natural History of Wiltshire* (1691) we find John Aubrey writing "I have often wished for a mappe, coloured according to the colours of the earths, with marks of the minerals." His wish was not fulfilled for many years, and maps showing the distribution of the strata were a later development still, owing to the confused and speculative state of men's ideas of the earth's crust. The story of the geological map in this volume is thus perforce developed alongside an account of the progress of geological thought and controversy.

The student cannot gain an accurate grasp of the scientific problems of to-day until he is familiar with the difficulties of past generations; the achievements of William Smith and the early pioneers cannot be appreciated until the advance their researches effected is realized. Such reminders of the past as this volume teach us to remember past controversies and their lesson for to-day.

Wales contains many areas classical in the history of geology; and the evolution of the geological map as we see it to-day is illustrated solely by those areas in which many perplexing problems have been investigated, and to some extent solved.

The complete list of published geological maps at the end of the volume is in itself a good bibliography for students of Welsh geology.

From Crystal to Television. By Vyvyan Richards. (A. & C. Black. 5s.).
Television. By Alfred Dinsdale. (The Television Press. 5s.).

There are many amateur wireless experimenters who will be glad to read Mr. Richards' little book. They will find many terms, familiar to them by name, cleverly and lucidly explained. The operation of wireless valves and the many ways in which they may be used in wireless transmission and reception are set forth with commendable clearness. The diagrams, of which there are quite a number, are well drawn and some of them are very striking.

In the introduction the author refers to gamma rays as belonging to a "family" of cathode rays—surely this is incorrect: cathode rays and gamma rays are entirely distinct and have quite a different nature.

There is a very helpful chapter on television which recites the difficulties encountered in the pioneer experiments and the methods that are being tried to overcome them. There is very little doubt that television has come to stay, and these early experiments are full of fascination. Fortunately, thanks to the widespread interest in wireless, there is no scarcity of potential experimenters, and much of the pioneer work is common to both lines of progress.

A concise summary of the state of television at the present time is given in the second volume, prefaced by an optimistic foreword by that pioneer to whom wireless is so much indebted—Dr. J. A. Fleming. The fact that Dr. Fleming has written the foreword is sufficient to guarantee the interest of the book. It seems that practical results have been obtained in television, noctovision, colour-television and stereo-television. There are, it appears to the reviewer, some important basic difficulties yet to be surmounted before universal commercial application is feasible, but the ingenuity of the experimental work described by Mr. Dinsdale is very remarkable. His accounts are, however, mainly concerned with the work of Mr. Baird, and in view of the general title of the book, not enough emphasis is given to possible alternative methods.

The author is to be congratulated upon his successful effort to condense most of the available knowledge concerning television into one small and very readable volume.

V. E. Pullin.

Philosophy To-day. A Series of Essays Collected and Edited by E. Leroy Schaub. (The Open Court Publishing Co. 18s.).

Shortly after the war, and about the time that the editor of this volume became editor of *The Monist*, arrangements were begun for the Sixth International Congress of Philosophy. In order that the journal should make some contribution to the success of the Congress, Schaub arranged for authoritative scholars to contribute surveys of the main fields of pholosophy especially cultivated by various linguistic groups since about the time of the outbreak of the war. This volume is a collection of these surveys, with but slight alterations and additions, and first published in *The Monist* from April, 1926 onwards; many of which were first published after the Congress.

Apart from the fact that unforeseen circumstances prevented the execution of arrangements which the editor thought had been made for accounts of present Italian philosophy, it is not claimed that the present survey is without gaps. However, the wide field of this survey, embracing as it does accounts of various aspects of contemporary philosophy in English, French and German speaking countries, in Scandinavia, Russia and South America, and its high standard, make it a valuable contribution towards an understanding of the difficulties arising from the philosophical isolation of the linguistic groups during the Great War.

The Modern Cat: Her Mind and Manners. By G. S. Gates, Ph.D. (Macmillan. 8s. 6d.).

The cat, as it has been for centuries, is still one of the commonest and most favoured of pets.

The reader is told that the tales here recorded "are intended for two classes of readers: those who love cats and would like to know more about the explanation for their actions, and those who may wish to obtain, through a description of methods employed with one animal, a first glimpse of comparative psychology." Yet the standard of this book certainly does not merit the given sub-title—an introduction to comparative psychology.